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Westinghouse Astronuclear Laboratory

A PROCEDURE FOR USING THE COMPUTER CODE OF NASA CR-710 TO OBTAIN THE TWO-D AXISYMMETRIC FLOWS BEHIND BLADE ROWS IN WET VAPOR TURBINES

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FOREWORD

The work described in this report was performed under NASA Contract NAS 7-390, "Basic Investigation of Turbine Erosion Phenomena". The work was done under the supervision of Mr. W. D. Pouchot of the Systems and Technology Department of the Westinghouse Astronuclear Laboratory. Mr. L. G. Hays of Jet Propulsion Laboratory is the NASA Program Manager.

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I. INTRODUCTION

This report is designed to be used in conjunction with NASA CR-710 (Reference 1) to give the user sufficient information so as to be capable of utilizing the NASA Performance Computer Code for Axial Flow Turbines as modified at WANL. The modified code is written entirely in FORTRAN IV for the CDC 6600 computer. But the code should be capable of being used with appropriate control cards on any computer having at least 32 K of core storage.

The following sections of the report give: the applicability and modifications made from the original code, definitions of the input and output nomenclature, a method for making the code input applicable for wet vapor turbines, suggestions for further possible future modifications, three sample problems illustrating the usage of the code, a FORTRAN listing of the entire code, and control cards showing proper deck setup. No attempt is made to discuss the method of calculation of turbine performance or to give computer flow diagrams since these topics are adequately covered in Reference (1). The modifications made to the code do not significantly change the original program logic or capability. These modifications for the most part were necessary to enable the code to accurately calculate wet vapor turbine performance. Ideal gas turbines can still be analyzed as well as air breathing fossil fuel burning turbines for which the code was originally primarily designed.

II. INTENT OF CODE

A. Applicability of Code and Limiting Assumptions

The principal purpose of the original code as written by E. E. Flagg[1] is to provide a complete performance map of axial flow turbines suitable for use in air breathing fossil fuel fired jet engines. In the process of accomplishing this end, the code calculates the two-dimensional bulk flow conditions fore and aft of the turbine rows.

1. Description and Scope of Modified Code

   (a) Axial flow turbines.

   (b) Up to 8 stages.

   (c) Up to 6 radial sectors (although only 5 are usually used for reasons of symmetry).

   (d) Each sector is a quasi-one-dimensional element with the properties at the radial centers of these sectors being joined; utilizing simple radial equilibrium at the stator and rotor exits.

   (e) Semi-perfect gas properties (gas constant and specific heat ratio) are assumed and are input at the entrance and exit of each blade row. Provision is also made to simulate changes in gas flow rates at the entrance and exit of each blade row. Energy balance effects are simulated by changing the values of the gas constant and specific heat ratio.

   (f) The turbine geometry may be either input as a passage distributed area (SPA and RPA)* or as effective exit vector flow angles (SDEA and RDEA).

---

* Nomenclature defined in Section III-A of this report.

The assumption that the effective exit flow angles are approximately equal to the design blade exit angles is usually valid. Mandatory inputs are the diameters of the root (DR) and tip (DT) for the entrance and exit of each blade row and the stator and rotor design inlet angles (SDIA and RDIA) for each of the radial sectors.

(g) Even though there are two subroutines (LØSS 1 and LØSS 2) which are capable of calculating losses by a total pressure loss coefficient method, the values for the coefficients of the series expansion are not generally known. See page 11 of NASA CR-710. The standard method is to input the values of optimum recovery coefficients for stator and rotor (SREC and RREC) together with exponents to be used in the event of both negative and positive (EXPN and EXPP) incidence. See page 10 of NASA CR-710 for equations used.

(h) Separate cases may be run for various turbine speeds by merely changing the RPM and indicating that is a change case (STGCH = 0.0).

(i) The FORTRAN IV code calculates a performance map for the case of a given turbine at a particular RPM by in effect varying the exit back pressure. The output for each "iteration" (i.e., value of back pressure) gives flow rates, velocities, flow angles, temperatures, pressures, densities, Mach numbers, efficiencies, and work done both for an overall stage output and also row-by-row output for each of the radial sectors. An exact choke point is found during the calculation of the performance map and the turbine back pressure is effectively further reduced until the discharge annulus area is choked at the pitchline sector (assuming AACS = 1.0). A single performance point can be obtained by simply setting all pressure ratio increments (DELC, DELL, and DELA) to zero. This is the usual case when fixed operating conditions are known at design.

(j) The gas flow at the entrance to the first stator is assumed to have uniform radial temperature, pressure, and velocity. The flow is further assumed to be exactly aligned with the turbine axial direction (i.e., no tangential velocity component).

B. Modifications to Code

As stated previously, as originally programmed the code was principally intended for analysis of JP-4 burning, air breathing jet engines. Internal to the code is a subroutine for calculating the thermodynamic properties of reacted JP-4-air mixtures. It also had a capability to input thermodynamic properties which was extended as required by the method used in determining the performance of wet vapor turbines. It was decided that the thermodynamic properties fore and aft of each blade row would be inputed in terms of representative values for the particular working fluid and its state. The variables to be input would be the ratio of specific heats at constant pressure to that at constant volume and Boyles and Charles Law gas constant. The internals of the program are then used to the calculate effective specific heat and various other effective thermodynamic properties.

The following modifications were made in the code:

1. Wherever the Boyles and Charles gas law constant RG appeared in the code, it was replaced by a two-dimensional variable RV (I, K) with proper choice of axial blade position I and stage number K to correspond to the location in the turbine for which the calculation is being performed.
2. A change was made in the input NAMELIST format to allow reading in of a variable RV. Also a modification was made to read in reference values for the gas constant, temperature, pressure, and specific heat ratio all at standard sea level conditions. Formerly the code contained these values for air internally in a DATA statement. But since gases other than air will be used, it was thought useful to include a capability for inputing these values for each case rather than requiring a recompilation whenever a different working fluid was used.

3. The output was expanded to print out the values for the flow, γ (ratio of specific heats), gas constant, and RWG (the ratio of the flow at a particular station to turbine inlet flow). To insure that these variables were being properly handled within the code, decreasing values of γ, RV, and RWG were fed in. The output was found to be consistent after a slight change in the logic.

4. Since values for γ and RV are now fed in for all cases, the subroutines to calculate γ, RG, and C_p's are superfluous since they would never be called upon. If by inadvertently omitting the inputing of γ and/or RV and subsequently a subroutine for calculating its value is entered, then an error message was added which would print out the words "SUBRØUTINE (___) HAS BEEN CALLED UPØN" followed by a string of asterisks so that attention would be immediately drawn to the error. The (____) is filled in by the name of the subroutine being called. After the error message is printed out, the calculation is allowed to proceed using properties for air, water, and JP-4 fuel.

5. On page 193 of NASA CR-710 the statement:

   ```
   21   PTP(I, K + 1) = PTBAR (K) * ( ( TTRA (I, K)/TTBAR (K) )** E 3      ST2A 153
   ```

   was found to be incorrect and should read:

   ```
   21   PTP(I, K + 1) = PTBAR (K) *   ( TT2A (I, K)/TTBAR (K)) ** E 3
   ```

6. On page 208 of NASA CR-710 the statement:

   ```
   ASOH = SQRT (GAM (I,K) * G * RG * STTSO(L) )                         INST 175
   ```

   was found to be incorrect and should read:

   ```
   ASOH = SQRT (GAM (1,K) * G * RG * STTSO(L) )
   ```

7. Any cards from the original code which had to be removed rather than modified were denoted by a comment card with the words "CARD DELETED" followed by a string of asterisks.

8. As an aid in debugging a computer run, an option was added to allow the printout of when entry and exit was made from each subroutine. This enables the user to examine the program logic as an aid in determining where discrepancies occur. This option is not recommended for other than debugging runs since a large amount of output results.

III. NOMENCLATURE FOR INPUT AND OUTPUT OF MODIFIED CODE

A. Input Definitions*

1. "TRUE" or "FALSE" card depending on whether or not a listing of when an entrance and exit is made from each subroutine is desired. This card is inputed only once per case.

2. Two heading cards of 60 characters each inputed only once per case.

3. Constants inputed only once per case:

Code Name	Definition	Units
STAGE **	Stage identification number	---
STGCH	Flag indicating whether following data is for the basic case (1.0) or for a change case (0.0)	---
TTIN	Turbine inlet total temperature	^{o}R
PTIN	Turbine inlet total pressure	psia
WAIR	Water to air ratio (not used in modified code); should be input as 0.0	---
FAIR	Fuel to air ratio (not used in modified code); should be input as 0.0	---
PTPS	Pitchline pressure ratio (total to static) across first stator for 0^{th} calculation. This ratio is incremented by DELC, DELL, or DELA for next calculation	---
DELC	First try at increment to PTPS	---
DELL	Increment to PTPS after first stator has critical flow and also when choke iteration is complete	---
DELA	Increment to PTPS when last rotor is choked	---
STG	Number of stages in turbine (8 maximum)	---
SECT	Number of radial sectors (6 maximum)	---

* Refer to Standard Option Input Sheet (page 11).

** Must be input every time new stage data is read in.

Code Name	Definition	Units
EXPN	Exponent of cosine term for negative incidence used in calculating an inlet recovery factor (see page 10 of Reference 1)	---
EXPP	Exponent of cosine term for positive incidence used in calculating an inlet recovery factor (see page 10 of Reference 1)	---
PAF	Profile averaging fork (either 0.0, 1.0, or 2.0); gives the next stage inlet conditions for either: uniform (0.0) at the average value of the preceding stage, or the radial sector profiles (1.0) of pressure and temperature of the preceding stage, or a third option which keeps the exit total temperature radial profile and "smooths" (2.0) the exit total pressure profile from the preceding stage	---
SLI	Stage loss indicator (0.0 means that recovery, efficiency, and flow coefficients are inputed for each stage; 1.0 means that they are inputed only once and are assumed constant throughout the turbine)	---
AACS	Discharge annulus area choke stop which is the maximum limit for the turbine exit axial Mach number at the pitch-line sector. This code will continue to decrease the back pressure until this limit is reached (assuming DELC, DELL, and DELA $\neq$ 0.0)	---
RPM	Turbine speed	RPM
VCTD	Vector diagram interstage output (either 0.0 for overall stage performance output only or 1.0 for row-by-row sector performance in addition to overall stage output printout)	---
RSL	Gas constant at sea level standard conditions	ft lb/lb $^{\circ}$R
TSL	Standard temperature at sea level = 518.688	$^{\circ}$R
PSL	Standard pressure at sea level = 14.696	psia
GAMSL	Specific heat ratio at sea level standard conditions	---
ENDSTG	0.0 if more stage data to follow; 1.0 if last stage data has been read in	---
ENDJØB	0.0 if more cases to follow; 1.0 if all data for all cases has been input	---
PCNH	Percent station height distribution (example: if 5 equal (in height) radial sectors were desired, then PCNH = 0.2, 0.2, 0.2, 0.2, 0.2)	---

4. Axial station input for each stage (stations 0, 1, 1A, 2, and 2A)

Code Name	Definition	Units
RG	Gas constant	ft lb/lb ^{o}R
GAMG	Specific heat ratio	---
DR	Diameter of root or hub of turbine	in
DT	Diameter of tip of turbine	in
RWG	Ratio of station flow to turbine inlet flow	---

5. Stator radial distributions for each stage (hub to tip sectors)

Code Name	Definition	Units
SDIA	Stator design inlet angle	(^{o} from axis)
SDEA	Stator effective exit flow angle — should not be input if SPA is input	(^{o} from axis)
SREC	Stator optimum recovery coefficient ($\eta_{sr_{opt}}$)	---
SETA	Stator efficiency coefficient (η_s)	---
SCF	Stator flow coefficient (C_{fs})	---
SPA	Stator passage area per unit height — should not be input if SDEA is input	in^2/in
SESTH *	Stator ratio of exit blade height to throat height	---

* Only a single value is input.

6. Rotor radial distributions for each stage (hub to tip sectors)

Code Name	Definition	Units
RDIA	Rotor design inlet angle	($^{\circ}$ from axis)
RDEA	Rotor effective exit flow angle — should not be input if RPA is input	($^{\circ}$ from axis)
RREC	Rotor optimum recovery coefficient ($\eta_{rr_{opt}}$)	---
RETA	Rotor efficiency coefficient (η_r)	---
RCF	Rotor flow coefficient (C_{fr})	---
RPA	Rotor passage area per unit height — should not be input if DREA is input	in^2/in
RTF	Rotor test factor used to represent the non-uniform work extraction due to blade end effects	---
RERTH *	Rotor ratio of exit blade height to throat height	---

* Only a single value is input.

WANL MODIFIED
TURBINE COMPUTER PROGRAM
STANDARD OPTION
INPUT SHEET

Start All Input Cards in Column 2

Subroutine Entry and Exit Listing Option (TRUE or FALSE)

Name (Comment Information)

Title (Comment Information)

```
$DATAIN  STAGE =    ,
STGCH=              ,
TTIN=               ,PTIN=          ,WAIR=          ,FAIR=          ,
PTPS=               ,DELC=          ,DELL=          ,DELA=          ,
STG=                ,SECT=          ,EXPN=          ,EXPP=          ,
PAF=                ,SLI=           ,AACS=          ,RPM=           ,
VCTD=               ,RSL=           ,TSL=           ,PSL=           ,
GAMSL=              ,ENDSTG=        ,ENDJØB=        ,
```

INLET RADIAL PROFILE

```
PCNH(1)=            ,        ,         ,         ,         ,
```

AXIAL STATIONS

```
              STA. 0    STA. 1    STA. 1A    STA. 2    STA. 2A
RG(1)=              ,         ,          ,         ,         ,
GAMG(1)=            ,         ,          ,         ,         ,
DR(1)=              ,         ,          ,         ,         ,
DT(1)=              ,         ,          ,         ,         ,
RWG(1)=             ,         ,          ,         ,         ,
```

STATOR RADIAL DISTRIBUTIONS

```
              ROOT               PITCH               TIP
SDIA(1)=            ,         ,          ,         ,         ,
SDEA(1)=            ,         ,          ,         ,         ,
SREC(1)=            ,         ,          ,         ,         ,
SETA(1)=            ,         ,          ,         ,         ,
SCF(1)=             ,         ,          ,         ,         ,
SPA(1)=             ,         ,          ,         ,         ,
SESTH=              ,
```

ROTOR RADIAL DISTRIBUTIONS

```
              ROOT               PITCH               TIP
RDIA(1)=            ,         ,          ,         ,         ,
RDEA(1)=            ,         ,          ,         ,         ,
RREC(1)=            ,         ,          ,         ,         ,
RETA(1)=            ,         ,          ,         ,         ,
RCF(1)=             ,         ,          ,         ,         ,
RPA(1)=             ,         ,          ,         ,         ,
RTF(1)=             ,         ,          ,         ,         ,
RERTH=              ,

ENDSTG=             ,     ENDSTG=1.0 IF LAST CASE
ENDJØB=             $     ENDJØB=1.0 IF LAST STAGE
```

B. Output Definitions

1. Station Nomenclature

The axial station numbers (0, 1, 1A, 2, and 2A) following a parameter refer to the following designations:

Station Number	0	1	1A	2	2A
Definition	Stator Inlet	Stator Exit	Rotor Inlet	Rotor Exit	Next Stage Stator Inlet

Also see Figure IV-1 on page 21 for further clarification of terminology.

In the stage and overall performance output printout several parameters are given in terms of the equivalent parameter referenced to standard sea level conditions. This provides a common basis for comparison of performance maps for different turbine cases.

2. Stage Performance Parameters

Symbol	Definition	Units
TTBAR 0	Stage average inlet total temperature	^{o}R
PTBAR 0	Stage average inlet total pressure	psia
WG 0	Stage inlet total weight flow	lb/sec
DEL H	Stage enthalpy drop (energy output)	BTU/lb
WRT/P	Stage corrected weight flow function	(lb/sec) $(^{o}R/psia)^{1/2}$
DH/TTBAR0	Stage energy function	BTU/lb ^{o}R
N/RT	Stage corrected speed	RPM/$(^{o}R)^{1/2}$
ETA TT	Stage total to total efficiency	---
ETA TS	Stage total to static efficiency	---
ETA AT	Stage total to axial total efficiency	---
PT0/PSI	Stator total to static pressure ratio at pitchline	---

Symbol	Definition	Units
PTBAR0/PTBAR2	Stage average total to total pressure ratio	---
PTBAR0/PS2	Stage average total to pitchline static pressure ratio	---
PTR2/PS2	Rotor exit relative total to static pressure ratio at pitchline	---
TTBAR2/TTBAR0	Stage average total to total temperature ratio	---
TTR1A/TTBAR0	Rotor inlet pitchline relative total to stage inlet average total temperature ratio	---
WG 1	Stator exit total weight flow	lb/sec
PS 1A	Rotor inlet static pressure at pitchline	psia
TTR 1A	Rotor inlet relative total temperature at pitchline	^{o}R
PTR 1A	Rotor inlet relative total pressure at pitchline	psia
WG 1A	Rotor inlet total weight flow	lb/sec
PS 2	Rotor exit static pressure at pitchline	psia
TTBAR 2	Stage exit average total temperature	^{o}R
PTBAR 2	Stage exit average total pressure	psia
WG 2	Rotor exit total weight flow	lb/sec
WG 2A	Next stage stator inlet total weight flow	lb/sec
UP/VI	Wheel speed to isentropic velocity ratio at pitchline	---
UR/VI	Root wheel speed to pitchline isentropic velocity ratio	---
PSI P	Kinetic energy loading parameter at pitchline	---
PSI R	Kinetic energy loading parameter at root	---
RX P	Reaction ratio at pitchline	---
RX R	Reaction ratio at root	---
ALPHA 0	Stator inlet gas angle at pitchline	^{o}
I STATOR	Stator inlet incidence angle at pitchline	^{o}
BETA 1A	Rotor inlet gas angle at pitchline	^{o}

Symbol	Definition	Units
I RØTØR	Rotor inlet incidence angle at pitchline	°
ALPHA 2A	Next stage stator inlet gas angle at pitchline	°
DBETA R	Rotor root turning angle	°
M 1	Stator exit Mach number at pitchline	---
M1 RT	Stator exit Mach number at root	---
MR 1A	Rotor inlet relative Mach number at pitchline	---
MR1A RT	Rotor inlet relative Mach number at root	---
MR 2	Rotor exit relative Mach number at pitchline	---
MR2 TIP	Rotor exit relative Mach number at tip	---
E/TH CR	Stage equivalent energy, corrected to standard inlet critical conditions	BTU/lb
N/RTH CR	Stage equivalent speed, corrected to standard inlet critical conditions	RPM
WRTHCRE/D	Stage equivalent flow, correct to standard inlet critical conditions	lb/sec

3. Overall Turbine Performance Parameters

Symbol	Definition	Units
PSI P	Overall kinetic energy loading parameter at pitchline	---
PSI R	Overall kinetic energy loading parameter at root	---
DEL H	Overall enthalpy drop (energy output)	BTU/lb
WRT/P	Turbine inlet corrected weight flow function	(lb/sec) $(^{o}R/psia)^{1/2}$
N/RT	Turbine inlet corrected speed	RPM/$(^{o}R)^{1/2}$
DELH/TTIN	Overall energy function	BTU/lb ^{o}R
PT0/PTBAR2	Overall average total pressure ratio	---
PT0/PS2	Overall total to static pressure ratio at pitchline	---
PT0/PAT2A	Overall total to axial total pressure ratio at pitchline	---

Symbol	Definition	Units
ETA TT	Overall total to total efficiency	---
ETA TS	Overall total to static efficiency	---
ETA TAT	Overall total to axial total efficiency	---
WNE/60D	Turbine inlet equivalent flow-speed parameter	lb/sec^2
N/RTH CR	Turbine inlet equivalent speed, corrected to standard inlet critical conditions	RPM
E/TH CR	Overall equivalent energy, corrected to standard inlet critical conditions	BTU/lb

4. Inter-Stage Radial Sector Performance Parameters

Symbol	Definition	Units
DIAM 0	Diameter of mid-points of radial sectors at stator inlet	in
TT 0	Total temperature at stator inlet	^oR
PT 0	Total pressure at stator inlet	psia
ALPHA 0	Gas angle (with respect to axial direction) at stator inlet	^{o}
I STATØR	Incidence angle at stator inlet	^{o}
V 0	Gas velocity (composed of tangential and axial components) at stator inlet	ft/sec
VU 0	Tangential gas velocity at stator inlet	ft/sec
VZ 0	Axial gas velocity at stator inlet	ft/sec
TS 0	Static temperature at stator inlet	^oR
PS 0	Static pressure at stator inlet	psia
DENS 0	Static density at stator inlet	lb/ft^3
M 0	Mach number at stator inlet	---
CP 0	Specific heat at constant pressure at station inlet	BTU/lb ^oR
RG 0	Gas constant at stator inlet	ft lb/lb ^oR

Symbol	Definition	Units
GAMG 0	Ratio of specific heats at stator inlet	---
RWG 0	Ratio of station flow to turbine inlet flow (by definition this must be 1.0 at the first stator inlet of turbine)	---
WG 0	Weight flow at stator inlet	lb/sec
DIAM 1	Diameter of mid-points of radial sectors at stator exit	in
ALPHA 1	Gas angle (with respect to axial direction) at stator exit	$^\circ$
DEL A	Gas turning angle $(\alpha_o + \alpha_1)$	$^\circ$
V 1	Gas velocity (composed of tangential and axial components (at stator exit	ft/sec
VU 1	Tangential gas velocity at stator exit	ft/sec
VZ 1	Axial gas velocity at stator exit	ft/sec
TS 1	Static temperature at stator exit	$^\circ R$
PS 1	Static pressure at stator exit	psia
DENS 1	Static density at stator exit	lb/ft^3
M 1	Mach number at stator exit	---
ZWI INC	Zweifel parameter, incompressible	---
CP S	Stator pressure coefficient, incompressible	---
CP 1	Specific heat at constant pressure at stator exit	BTU/lb $^\circ R$
RG 1	Gas constant at stator exit	ft lb/lb $^\circ R$
GAMG 1	Ratio of specific heats at stator exit	---
RWG 1	Ratio of stator exit flow to turbine inlet flow	---
WG 1	Weight flow at stator exit	lb/sec
DIAM 1A	Diameter of mid-points of radial sectors at root inlet	in
PTR 1A	Relative total pressure at rotor inlet	psia
TTR 1A	Relative total temperature at rotor inlet	$^\circ R$
BETA 1A	Relative gas angle at rotor inlet	$^\circ$

Symbol	Definition	Units
I RØTØR	Incidence angle at rotor inlet	°
R 1A	Relative gas velocity at rotor inlet	ft/sec
RU 1A	Relative gas tangential velocity at rotor inlet	ft/sec
MR 1A	Relative Mach number at rotor inlet	---
U 1A	Wheel speed at rotor inlet	ft/sec
PS 1A	Static pressure at rotor inlet	psia
TS 1A	Static temperature at rotor inlet	°R
CP 1A	Specific heat at constant pressure at rotor inlet	BTU/lb °R
RG 1A	Gas constant at rotor inlet	ft lb/lb °R
GAMG 1A	Ratio of specific heats at rotor inlet	---
RWG 1A	Ratio of rotor inlet flow to turbine inlet flow	---
WG 1A	Weight flow at rotor inlet	lb/sec
DIAM 2	Diameters of mid-points of radial sectors at rotor exit	in
PTR 2	Relative total pressure at rotor exit	psia
TTR 2	Relative total temperature at rotor exit	°R
BETA 2	Relative gas angle at rotor exit	°
DBETA	Gas turning angle ($\beta_{1A} + \beta_2$)	°
R 2	Relative gas velocity at rotor exit	ft/sec
RU 2	Relative tangential gas velocity at rotor exit	ft/sec
MR 2	Relative Mach number at rotor exit	---
U 2	Wheel speed at rotor exit	ft/sec
RX	Reaction	---
DELH	Enthalpy drop (energy output)	BTU/lb
PSI P	Kinetic energy loading parameter	---
ETA TT	Total to total efficiency	---
ETA TS	Total to static efficiency	---
ETA AT	Total to axial total efficiency	---

Symbol	Definition	Units
ZWI INC	Zweifel parameter, incompressible	---
CP R	Rotor pressure coefficient, incompressible	---
PS 2	Static pressure at rotor exit	psia
TS 2	Static temperature at rotor exit	^{o}R
CP 2	Specific heat at constant pressure at rotor exit	BTU/lb ^{o}R
RG 2	Gas constant at rotor exit	ft lb/lb ^{o}R
GAMG 2	Ratio of specific heats at rotor exit	---
RWG 2	Ratio of rotor exit flow to turbine inlet flow	---
WG 2	Weight flow at rotor exit	lb/sec
PT 2A	Total pressure at inlet to next stator	psia
TT 2A	Total temperature at inlet to next stator	^{o}R
V 2A	Gas velocity (composed of tangential and axial components) at inlet to next stator	ft/sec
VU 2A	Tangential gas velocity at inlet to next stator	ft/sec
ALPHA 2A	Gas angle (with respect to axial direction) at inlet to next stator	^{o}
MF 2A	Axial Mach number at inlet to next stator	---
VZ 2A	Axial gas velocity at inlet to next stator	ft/sec
TS 2A	Static temperature at inlet to next stator	^{o}R
PS 2A	Static pressure at inlet to next stator	psia
DENS 2A	Static density at inlet to next stator	lb/ft^3
M 2A	Mach number at inlet to next stator	---
CP 2A	Specific heat at constant pressure at inlet to next stator	BTU/lb ^{o}R
RG 2A	Gas constant at inlet to next stator	ft lb/lb ^{o}R
GAMG 2A	Ratio of specific heats at inlet to next stator	---
RWG 2A	Ratio of flow at inlet to next stator to turbine inlet flow	---
WG 2A	Weight flow at inlet to next stator	lb/sec

IV. METHOD FOR CALCULATION OF MODIFIED PARAMETERS FOR WET VAPOR TURBINES

A. Assumptions Used and Development of Equations for Modified Parameters

In wet vapor turbines since there exists two distinct phases (gas and liquid), the usual ideal thermodynamic relationships which are valid for gas turbines are not directly applicable. The approach used to determine the performance of wet vapor turbines involved making a minimum of changes in the code but required modifying the input data appropriately to closely simulate the thermodynamic processes of a turbine operating within the saturation dome of a T-S (temperature-entropy) diagram. The following method was derived and gives good agreement with the results from the WSD 2-D code as run by Fentress[2].

In order to arrive at a consistent set of relatively simple relationships, the following assumptions were made:

1. The inlet hub and tip diameters for a given blade row are assumed equal to the exit hub and tip diameters from the preceding blade row. The same assumption holds true for the modified parameters γ^*, η^*, and R^*. The superscript * indicates that it is a modified value for specific heat ratio, blade efficiency, and gas constant.

2. All inefficiencies are assumed to be lumped into the single blade efficiency parameter η^*. This includes such items as incidence and exit losses and flow coefficients. Consequently EXPP = EXPN = 0.0, SREC = RREC = 1.0, SCF = RCF = 1.0, RTF = 1.0, and SESTH = RERTH = 1.0. The definitions of these computer code terms may be found in Section III-A.

3. The exit gas flow angle from each blade row is taken to be equal to the exit blade angle. Therefore, actual blade exit angles (SDEA and RDEA) are input rather than distributed passage areas (SPA and RPA).

4. Since all energy changes are accounted for in the calculation of the modified parameters, there is no need to take into consideration the decrease in the gas flow rate due to condensation effects. Consequently RWG = 1.0.

5. Radial variations in γ^*, η^*, and R^* are assumed to be negligible.

In applying the following formulas to determine the modified values of R^*, γ^*, and η^*, care must be exercised to obtain the proper relative velocity either entering or leaving a blade row. See Figure IV-1 for clarification of the station terminology used in the example potassium turbine. The initial values for static temperatures, pressures, specific volumes, and velocities are obtained from previous 1-D calculations. Definitions of the nomenclature used are given in Section IV-B.

FIFTH STAGE

$$R^*_0 = \frac{144\, P_{S0}\, v_{S0}}{T_{S0}} \tag{1}$$

$$\gamma^*_0 = \frac{1}{1 - \dfrac{2gR^*_0 (T_{T0} - T_{S0})}{V_0^2}} \tag{2}$$

$$P^*_{T0} = P_{S0} \left(\frac{T_{T0}}{T_{S0}} \right)^{\dfrac{\gamma^*_0}{\gamma^*_0 - 1}} \tag{3}$$

$$PTPS = \frac{P^*_{T0}}{P_{S1}} \tag{4}$$

$$R^*_1 = \frac{144\, P_{S1}\, v_{S1}}{T_{S1}} \tag{5}$$

$$\gamma^*_1 = \frac{1}{1 - \dfrac{2gR^*_1 (T_{T0} - T_{S1})}{V_1^2}} \tag{6}$$

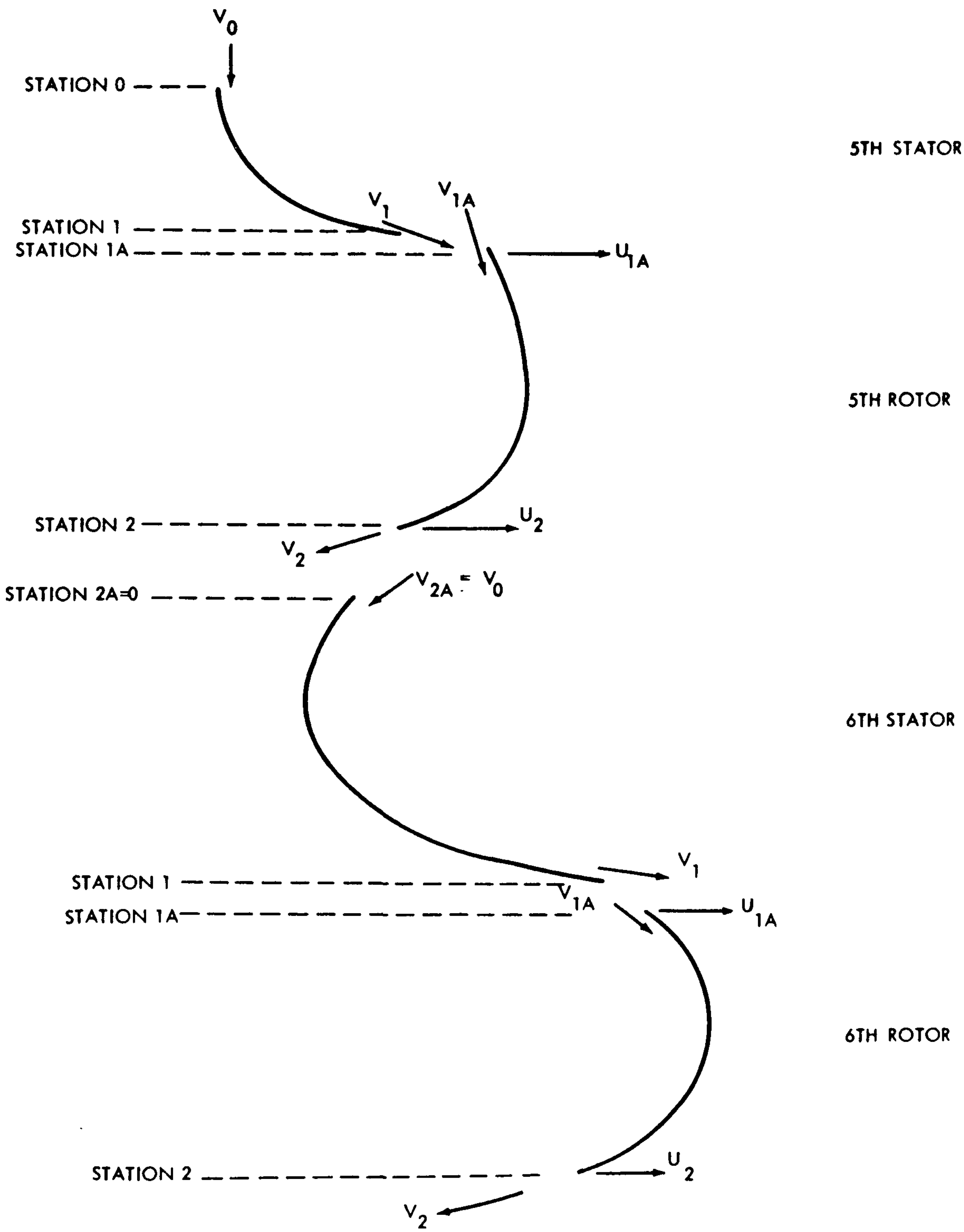


Figure IV-1. Axial Station Velocity Nomenclature

$$\eta^*_1 = \frac{T_{T0} - T_{S1}}{T_{T0}\left[1 - \left(\frac{P_{S1}}{P^*_{T0}}\right)^{\frac{\gamma^*_1 - 1}{\gamma^*_1}}\right]} \tag{7}$$

$$D^*_{R1A} = D_{R1} \tag{8}$$

$$D^*_{T1A} = D_{T1} \tag{9}$$

$$R^*_{1A} = R^*_1 \tag{10}$$

$$\gamma^*_{1A} = \gamma^*_1 \tag{11}$$

$$R^*_2 = \frac{144\, P_{S2}\, v_{S2}}{T_{S2}} \tag{12}$$

$$T_{T2g} = T_{S1A} + \frac{\left(\gamma^*_{1A} - 1\right)\left(V^2_{1A} + U^2_2 - U^2_{1A}\right)}{2g\, \gamma^*_{1A}\, R^*_{1A}} \tag{13}$$

$$P_{T2g} = P_{S1A}\left[1 + \frac{\left(\gamma^*_{1A} - 1\right)\left(V^2_{1A} + U^2_2 - U^2_{1A}\right)}{2g\, \gamma^*_{1A}\, R^*_{1A}\, T_{S1A}}\right]^{\frac{\gamma^*_{1A}}{\gamma^*_{1A} - 1}} \tag{14}$$

$$\gamma^*_2 = \frac{1}{1 - \frac{2g\, R^*_2\, (T_{T2g} - T_{S2})}{V^2_2}} \tag{15}$$

$$\eta^*_2 = \frac{T_{T2g} - T_{S2}}{T_{T2g}\left[1 - \left(\frac{P_{S2}}{P_{T2g}}\right)^{\frac{\gamma^*_2 - 1}{\gamma^*_2}}\right]} \tag{16}$$

$$D^*_{R2A} = D_{R2} \tag{17}$$

$$D^*_{T2A} = D_{T2} \tag{18}$$

$$R^*_{2A} = R^*_2 \tag{19}$$

$$\gamma^*_{2A} = \gamma^*_2 \tag{20}$$

$$D^*_{R0} = D^*_{R2A} \tag{21}$$

$$D^*_{T0} = D^*_{T2A} \tag{22}$$

$$R^*_0 = R^*_{2A} \tag{23}$$

$$\gamma^*_0 = \gamma^*_{2A} \tag{24}$$

$$R^*_1 = \frac{144\, P_{S1}\, v_{S1}}{T_{S1}} \tag{25}$$

$$T_{T0g} = T_{S2A} + \frac{V^2_{2A}}{\dfrac{2g\, \gamma^*_{2A}\, R^*_{2A}}{\gamma^*_{2A} - 1}} \tag{26}$$

$$P_{T0g} = P_{S2A} \left(\frac{T_{T0g}}{T_{S2A}} \right)^{\dfrac{\gamma^*_{2A}}{\gamma^*_{2A} - 1}} \tag{27}$$

$$\gamma^*_1 = \frac{1}{1 - \dfrac{2g\, R^*_1 \left(T_{T0g} - T_{S1}\right)}{V^2_1}} \tag{28}$$

$$\eta^*_1 = \frac{T_{T0g} - T_{S1}}{T_{T0g} \left[1 - \left(\dfrac{P_{S1}}{P_{T0g}} \right)^{\dfrac{\gamma^*_1 - 1}{\gamma^*_1}} \right]} \tag{29}$$

The remainder of the expressions for the modified parameters for the rest of the sixth stage are the same as those in Equations (8) through (20). For turbines with more than two stages, the same relationships are repeated for each succeeding stage. Since there is a significant amount of hand calculations involved in obtaining the modified parameters, a small computer program could be written to punch out these values in a format compatible with the input to the modified NASA turbine code.

B. Nomenclature Used in Calculation of Modified Parameters

Symbol	Definition	Units
D_R	Root diameter	in
D_T	Tip diameter	in
g	Gravitational acceleration (32.2)	ft/sec^2
P_S	Static pressure	psia
P_T	Total pressure	psia
PTPS	Total-to-static pressure ratio across first stator	---
R	Gas constant	$ft/^{o}R$
T_S	Static temperature	^{o}R
T_T	Total temperature	^{o}R
U	Wheel speed	ft/sec
V	Gas velocity	ft/sec
v_S	Specific volume	ft^3/lb
γ	Ratio of specific heats	---
η	Overall effective blade efficiency	---

V. POSSIBLE FUTURE MODIFICATION TO CODE

1. With the advent of the CDC 6600 computer and its 65 K core (as compared to the IBM 7094 and its core of 32 K), it is possible to expand the maximum number of radial sectors to greater than 6 and the maximum number of stages to exceed 8. Of course computer run times would be longer and a different method of printing out data would have to be used.

2. The code could be changed so as to iterate to a desired exit pressure condition automatically by comparing the average turbine exit total pressure with that desired. If the difference between the exit total pressures were not within some given tolerance, the first stator pressure ratio PTPS would be adjusted accordingly.

3. Non-uniform turbine inlet radial distributions in pressure, temperature, and velocity could be achieved by inputing such quantities. The assumption in the code as presently programmed is that the inlet radial distributions are uniform.

REFERENCES

(1) E. E. Flagg, "Analytical Procedure and Computer Program for Determining the Off-Design Performance of Axial Flow Turbines", NASA CR-710, February 1967.

(2) Westinghouse Electric Corporation, Astronuclear Laboratory, Report WANL-PR(DD)-017, January 1967, Contract NAS 7-390.

APPENDIX I

SAMPLE PROBLEMS ILLUSTRATING USE OF CODE

A. NASA Reference Two-Stage Gas Turbine (5 Radial Sectors)

1. Comparison of Results

The sample problem given in NASA CR-710 was run both on the IBM 7094 (II) and CDC 6600 computer. The data output from both machines was in exact agreement to at least the sixth significant figure. The minor discrepancies noted were thought to be due to the difference in the number of significant places carried in the respective machines. It was found that the sample problem data output given in NASA CR-710 did not exactly correspond to that report's data input. When the data input was appropriately changed, the subsequent output was in substantial agreement (at least to the fourth significant place) with that given in NASA CR-710. No explanation can be given at this time as to why there was not agreement to at least the sixth place. But it is felt that the agreement is more than adequate to satisfy engineering criteria.

2. Data Input

```
                        TURBINE COMPUTER PROGRAM
   NASA TWO STAGE REFERENCE TURBINE
   1.00  5041  -8  DEG.  LOSS  PROFILE  .98  .946,  .977  .90,
$DATAIN
 STGCH=     1.000
  TTIN=   700.000   PTIN=    17.140   WAIR=     0.000  FAIR=     0.000
  PTPS=     1.600   DELC=     0.000   DELL=     0.000  DELA=     0.000
   STG=     2.000   SECT=     5.000   EXPN=     3.000  EXPP=     3.000
   PAF=     0.000    SLI=     0.000   AACS=     1.000   RPM=  5041.000
  VCTD=     1.000    RSL=    53.350    TSL=   518.688   PSL=    14.696
 GAMSL=     1.400 ENDSTG=     0.000 ENDJOB=     0.000

                        INLET RADIAL PROFILES
  PCNH=    .200     .200     .200     .200     .200     0.000
```

2. Data Input (continued)

STANDARD CPTION

STAGE= 1

AXIAL STATIONS

	STA. 0	STA. 1	STA.1A	STA. 2	STA.2A	
RG=	53.350	53.350	53.350	53.350	53.350	0.000
GAMG=	1.400	1.400	1.400	1.400	1.400	0.000
DR=	19.110	19.110	18.969	18.406	18.265	0.000
DT=	28.000	28.000	28.141	28.704	28.845	0.000
RWG=	1.000	1.000	1.000	1.000	1.000	0.000

STATOR RADIAL DISTRIBUTIONS

	ROOT		PITCH		TIP	
SDIA=	0.000	0.000	0.000	0.000	0.000	0.000
SDEA=	0.000	0.000	0.000	0.000	0.000	0.000
SREC=	1.000	1.000	1.000	1.000	1.000	0.000
SETA=	.970	.980	.980	.980	.970	0.000
SCF=	.977	.977	.977	.977	.977	0.000
SPA=	22.140	26.035	30.135	34.194	38.499	0.000
SESTH=	1.000					

ROTOR RADIAL DISTRIBUTIONS

RDIA=	50.600	44.900	38.100	30.200	20.900	0.000
RDEA=	0.000	0.000	0.000	0.000	0.000	0.000
RREC=	1.000	1.000	1.000	1.000	1.000	0.000
RETA=	.919	.946	.946	.946	.919	0.000
RCF=	.950	.950	.950	.950	.950	0.000
RPA=	33.408	36.352	38.976	41.280	43.008	0.000
RTF=	1.000	1.000	1.000	1.000	1.000	0.000
RERTH=	1.010					

STANDARD CPTION

STAGE= 2

AXIAL STATIONS

	STA. 0	STA. 1	STA.1A	STA. 2	STA.2A	
RG=	53.350	53.350	53.350	53.350	53.350	0.000
GAMG=	1.400	1.400	1.400	1.400	1.400	0.000
DR=	18.265	17.814	17.673	17.110	17.110	0.000
DT=	28.845	29.296	29.437	30.000	30.000	0.000
RWG=	1.000	1.000	1.000	1.000	1.000	0.000

STATOR RADIAL DISTRIBUTIONS

	ROOT		PITCH		TIP	
SDIA=	25.000	22.400	20.200	18.300	16.600	0.000
SDEA=	0.000	0.000	0.000	0.000	0.000	0.000
SREC=	1.000	1.000	1.000	1.000	1.000	0.000
SETA=	.970	.980	.980	.980	.970	0.000
SCF=	.925	.925	.925	.925	.925	0.000
SPA=	30.420	36.855	43.485	50.765	58.240	0.000

SESTH= 1.010

ROTOR RADIAL DISTRIBUTIONS

RDIA=	36.600	26.900	16.100	4.600	-6.700	0.000
RDEA=	0.000	0.000	0.000	0.000	0.000	0.000
RREC=	1.000	1.000	1.000	1.000	1.000	0.000
RETA=	.919	.946	.946	.946	.919	0.000
RCF=	.900	.900	.900	.900	.900	0.000
RPA=	43.350	48.150	52.350	55.750	58.550	0.000
RTF=	1.000	1.000	1.000	1.000	1.000	0.000
RERTH=	1.010					

3. Listing of Data Output

NASA TURBINE COMPUTER PROGRAM
NASA TWO STAGE REFERENCE TURBINE
1.00 5041 -8 DEG. LOSS PROFILE .98 .946, .977 .90,
CASE 1. 0
STAGE PERFORMANCE

	STAGE 1	STAGE 2	STAGE 3	STAGE 4
TTBAR 0	700.0	608.5		
PTBAR 0	17.140	10.120		
WG 0	43.612	43.612		
DEL H	21.960	11.370		
WRT/P	67.320	106.303		
DH/TTBAR0	.03137	.01869		
N/RT	190.532	204.358		
ETA TT	.93545	.93026		
ETA TS	.82312	.74101		
ETA AT	.92064	.92376		
PT0/PS1	1.600	1.327		
PTBAR0/PTBAR2	1.694	1.358		
PTBAR0/PS2	1.840	1.475		
PTR2/PS2	1.340	1.216		
TTBAR2/TTBAR0	.86926	.92212		
TTR1A/TTBAR0	.91710	.94793		
WG 1	43.612	43.612		
PS 1A	10.770	7.659		
TTR 1A	642.0	576.8		
PTR 1A	12.478	8.343		
WG 1A	43.612	43.612		
PS 2	9.314	6.860		
TTBAR 2	608.5	561.1		
PTBAR 2	10.120	7.452		
WG 2	43.612	43.612		
WG 2A	43.612	43.612		
UP/VI	.44821	.59095		
UR/VI	.35559	.43632		
PSI P	1.02409	.53026		
PSI R	1.62705	.97270		
RX P	.21420	.26054		
RX R	-.08793	-.07253		
ALPHA 0	0.000	20.327		
I STATOR	0.000	.127		
BETA 1A	46.336	15.343		
I ROTOR	8.236	-.757		
ALPHA 2A	20.327	-9.299		
DBETA R	116.216	86.338		
M 1	.83798	.64215		
M1 RT	1.01118	.78439		
MR 1A	.47064	.35196		
MR1A RT	.69181	.50438		
MR 2	.64048	.52077		
MR2 TIP	.69787	.61846		
E/TH CR	16.272	9.692		
N/RTH CR	4339.3	4654.2		
WRTHCRE/C	43.440	68.594		

OVERALL PERFORMANCE

PSI P	.77717	PSI R	1.32335	DEL H	33.33004
WRT/P	67.31951	N/RT	190.53189	DELH/TTIN	.04761
PT0/PTBAR2	2.29991	PT0/PS2	2.49847	PT0/PAT2A	2.30903
ETA TT	.93700	ETA TS	.86213	ETA TAT	.93477
WNE/60C	3141.641	N/RTH CR	4339.329	E/TH CR	24.69720

3. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
NASA TWO STAGE REFERENCE TURBINE
1.00 5041 -8 DEG. LOSS PROFILE .98 .946, .977 .90,
CASE 1. 0
INTER-STAGE PERFORMANCE

STA 0	STATOR INLET		STAGE 1.				
DIAM 0	19.999	21.777	23.555	25.333	27.111		
TT 0	700.0	700.0	700.0	700.0	700.0		
PT 0	17.140	17.140	17.140	17.140	17.140		
ALPHA 0	0.000	0.000	0.000	0.000	0.000		
I STATOR	0.000	0.000	0.000	0.000	0.000		
V 0	299.463	299.463	299.463	299.463	299.463		
VU 0	0.000	0.000	0.000	0.000	0.000		
VZ 0	299.463	299.463	299.463	299.463	299.463		
TS 0	692.5	692.5	692.5	692.5	692.5		
PS 0	16.509	16.509	16.509	16.509	16.509		
DENS 0	.06434	.06434	.06434	.06434	.06434		
M 0	.23213	.23213	.23213	.23213	.23213		
CP 0	.23996	.23996	.23996	.23996	.23996		
RG 0	53.350	53.350	53.350	53.350	53.350		
GAMG 0	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 0	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 0	6.58435	7.70666	8.60273	9.78081	10.73712	43.61168	TOTAL FLOW
STA 1	STATOR EXIT						
DIAM 1	19.999	21.777	23.555	25.333	27.111		
ALPHA 1	69.539	67.940	66.303	64.911	63.359		
DEL A	69.539	67.940	66.303	64.911	63.359		
V 1	1147.972	1080.202	1017.726	954.148	895.217		
VU 1	1075.549	1001.125	931.914	864.123	800.175		
VZ 1	401.291	405.692	409.026	404.586	401.413		
TS 1	590.3	602.9	613.8	624.2	633.3		
PS 1	9.252	10.046	10.712	11.379	11.936		
DENS 1	.04230	.04498	.04711	.04920	.05087		
M 1	.96384	.89743	.83798	.77904	.72567		
ZWI INC	-.65502	-.69615	-.73603	-.76804	-.80159		
CP S	.93195	.92314	.91342	.90150	.88810		
CP 1	.23996	.23996	.23996	.23996	.23996		
RG 1	53.350	53.350	53.350	53.350	53.350		
GAMG 1	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 1	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1	6.58435	7.70666	8.60273	9.78081	10.73712	43.61168	TOTAL FLOW

3. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
NASA TWO STAGE REFERENCE TURBINE
1.00 5041 -8 DEG. LOSS PROFILE .98 .946. .977 .90.
CASE 1. 0
INTER-STAGE PERFORMANCE

STA 1A	ROTOR INLET		STAGE 1.				
DIAM 1A	19.886	21.721	23.555	25.389	27.224		
PTR 1A	11.994	12.251	12.478	12.778	13.083		
TTR 1A	637.2	639.2	642.0	645.8	650.4		
BETA 1A	58.685	53.188	46.336	37.964	27.212		
I ROTOR	8.085	8.288	8.236	7.764	6.312		
R 1A	754.102	656.963	572.034	493.769	433.126		
RU 1A	644.243	525.969	413.810	303.751	198.059		
MR 1A	.63340	.54564	.47064	.40274	.35068		
U 1A	437.407	477.755	518.104	558.452	598.801		
PS 1A	9.225	10.067	10.770	11.461	12.035		
TS 1A	589.8	603.3	614.7	625.5	634.8		
CP 1A	.23996	.23996	.23996	.23996	.23996		
RG 1A	53.350	53.350	53.350	53.350	53.350		
GAMG 1A	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 1A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1A	6.58435	7.70666	8.80273	9.78081	10.73712	43.61168	TOTAL FLOW

STA 2	ROTOR EXIT						
DIAM 2	19.436	21.495	23.555	25.615	27.674		
PTR 2	11.947	12.225	12.478	12.810	13.154		
TTR 2	636.5	638.8	642.0	646.3	651.4		
BETA 2	57.531	58.629	59.379	60.258	60.964		
UBETA	116.216	111.817	105.715	98.223	88.175		
R 2	700.060	738.948	764.765	797.556	818.486		
RU 2	590.630	630.922	656.123	692.496	715.611		
MR 2	.58512	.61884	.64048	.64793	.68411		
U 2	427.500	472.802	518.104	563.406	608.708		
RX	-.00402	.11699	.21420	.30756	.38295		
DELH	21.683	22.139	22.182	22.137	21.658		
PST P	2.90236	2.45376	2.06895	1.76143	1.48743		
ETA TT	.91418	.94184	.94518	.94752	.92554		
ETA TS	.80596	.82681	.83127	.83236	.81639		
ETA AT	.89419	.92233	.92980	.93438	.91677		
ZWI INC	-1.85326	-1.61317	-1.42033	-1.24554	-1.09099		
CP R	-.16035	.20959	.44051	.61671	.71997		
PS 2	9.277	9.298	9.314	9.330	9.342		
TS 2	595.7	593.3	593.3	593.3	595.7		
CP 2	.23996	.23996	.23996	.23996	.23996		
RG 2	53.350	53.350	53.350	53.350	53.350		
GAMG 2	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 2	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2	6.89815	7.85826	8.73519	9.66391	10.45615	43.61166	TOTAL FLOW
PT 2A	10.061	10.112	10.122	10.148	10.138		
TT 2A	609.6	607.7	607.6	607.7	609.7		
V 2A	402.148	406.590	403.078	404.007	398.169		
VU 2A	164.083	158.536	140.019	128.806	106.469		
ALPHA 2A	24.080	22.949	20.327	18.592	15.509		
MF 2A	.30674	.31338	.31636	.32046	.32044		
VZ 2A	367.151	374.409	377.978	382.924	383.670		
TS 2A	596.2	594.0	594.0	594.2	596.5		
PS 2A	9.304	9.334	9.355	9.376	9.391		
DFNS 2A	.04213	.04241	.04251	.04259	.04249		
M 2A	.33598	.34032	.33736	.33811	.33255		
CP 2A	.23996	.23996	.23996	.23996	.23996		
RG 2A	53.350	53.350	53.350	53.350	53.350		
GAMG 2A	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 2A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2A	6.89815	7.85826	8.73519	9.66391	10.45615	43.61166	TOTAL FLOW

3. Output Data (continued)

```
                NASA TURBINE COMPUTER PROGRAM
NASA TWO STAGE REFERENCE TURBINE
1.00  5041  -8  DEG.  LOSS  PROFILE  .98  .946,  .977  .90,
                         CASE  1.  0
                   INTER-STAGE PERFORMANCE
```

STA 0	STATOR INLET		STAGE 2.				
DIAM 0	19.323	21.439	23.555	25.671	27.787		
TT 0	608.5	608.5	608.5	608.5	608.5		
PT 0	10.120	10.120	10.120	10.120	10.120		
ALPHA 0	24.080	22.949	20.327	18.592	15.509		
I STATOR	-.920	.549	.127	.292	-1.090		
V 0	402.148	406.590	403.078	404.007	398.169		
VU 0	164.083	158.536	140.019	128.806	106.469		
VZ 0	367.151	374.409	377.978	382.924	383.670		
TS 0	596.2	594.0	594.0	594.2	596.5		
PS 0	9.304	9.334	9.355	9.376	9.391		
DENS 0	.04213	.04241	.04251	.04259	.04249		
M 0	.33598	.34032	.33736	.33811	.33255		
CP 0	.23996	.23996	.23996	.23996	.23996		
RG 0	53.350	53.350	53.350	53.350	53.350		
GAMG 0	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 0	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 0	6.89815	7.85826	8.73519	9.66391	10.45615	43.61166	TOTAL FLOW

STA 1	STATOR EXIT						
DIAM 1	18.962	21.259	23.555	25.851	28.148		
ALPHA 1	61.651	59.301	57.068	54.670	52.234		
DEL A	85.731	82.250	77.395	73.262	67.744		
V 1	852.196	795.576	746.339	695.126	650.709		
VU 1	749.990	684.085	626.415	567.111	514.398		
VZ 1	404.665	406.164	405.742	401.978	398.519		
TS 1	548.0	555.8	562.1	568.3	573.2		
PS 1	6.934	7.321	7.624	7.926	8.158		
DENS 1	.03415	.03556	.03661	.03765	.03841		
M 1	.74259	.68839	.64215	.59484	.55441		
ZWI INC	-1.03734	-1.09869	-1.13154	-1.16854	-1.17646		
CP S	.77731	.73881	.70832	.66221	.62558		
CP 1	.23996	.23996	.23996	.23996	.23996		
RG 1	53.350	53.350	53.350	53.350	53.350		
GAMG 1	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 1	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1	6.56380	7.69027	8.76394	9.70979	10.79383	43.61164	TOTAL FLOW

3. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
NASA TWO STAGE REFERENCE TURBINE
1.00 5041 -8 DEG. LOSS PROFILE .98 .946, .977 .90,
CASE 1. 0
INTER-STAGE PERFORMANCE

STA 1A	ROTOR INLET		STAGE 2.				
DIAM 1A	18.849	21.202	23.555	25.908	28.261		
PTR 1A	7.983	8.161	8.343	8.600	8.871		
TTR 1A	570.7	573.3	576.8	581.8	587.6		
BETA 1A	40.535	28.960	15.343	-.585	-15.815		
I ROTOR	3.935	2.060	-.757	-5.185	-9.115		
R 1A	522.962	453.435	409.333	389.963	400.905		
RU 1A	339.876	219.552	108.311	-3.979	-109.261		
MR 1A	.45573	.39220	.35196	.33344	.34128		
U 1A	414.602	466.353	518.104	569.855	621.606		
PS 1A	6.930	7.341	7.659	7.970	8.209		
TS 1A	548.0	556.2	562.9	569.2	574.3		
CP 1A	.23996	.23996	.23996	.23996	.23996		
RG 1A	53.350	53.350	53.350	53.350	53.350		
GAMG 1A	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 1A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1A	6.56380	7.69027	8.76394	9.79979	10.79383	43.61164	TOTAL FLOW
STA 2	ROTOR EXIT						
DIAM 2	18.399	20.977	23.555	26.133	28.711		
PTR 2	7.950	8.142	8.343	8.625	8.926		
TTR 2	570.0	573.0	576.8	582.3	588.7		
BETA 2	45.803	47.980	49.600	51.528	52.888		
DBETA	86.338	76.940	64.943	50.944	37.072		
R 2	510.818	558.390	597.132	646.661	685.002		
RU 2	366.232	414.834	454.736	506.279	546.256		
MR 2	.44500	.48703	.52077	.56377	.59605		
U 2	404.695	461.399	518.104	574.808	631.513		
RX	.02767	.16069	.26054	.35780	.43067		
DELH	11.872	11.918	11.652	11.307	10.570		
PSI P	1.77102	1.38665	1.08674	.86417	.67406		
ETA TT	.92499	.94980	.94776	.94026	.89652		
ETA TS	.77200	.77551	.75903	.73739	.69018		
ETA AT	.92288	.94655	.94164	.93302	.88571		
ZWI INC	-1.83075	-1.49053	-1.21766	-.96625	-.75608		
CP R	-.04811	.34059	.53009	.63634	.65747		
PS 2	6.855	6.857	6.860	6.863	6.867		
TS 2	548.3	547.0	547.1	547.5	549.6		
CP 2	.23996	.23996	.23996	.23996	.23996		
RG 2	53.350	53.350	53.350	53.350	53.350		
GAMG 2	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 2	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2	6.21734	7.46048	8.67619	10.00385	11.25376	43.61162	TOTAL FLOW
PT 2A	7.334	7.389	7.439	7.491	7.537		
TT 2A	559.0	558.8	559.9	561.4	564.4		
V 2A	358.174	376.670	392.171	408.102	422.019		
VU 2A	-38.463	-46.565	-63.368	-68.529	-85.256		
ALPHA 2A	-6.165	-7.101	-9.299	-9.667	-11.655		
MF 2A	.31022	.32601	.33752	.35074	.35964		
VZ 2A	356.102	373.780	387.017	402.308	413.318		
TS 2A	548.3	547.0	547.1	547.5	549.6		
PS 2A	6.855	6.857	6.860	6.863	6.867		
DENS 2A	.03374	.03384	.03384	.03384	.03372		
M 2A	.31202	.32853	.34202	.35579	.36721		
CP 2A	.23996	.23996	.23996	.23996	.23996		
RG 2A	53.350	53.350	53.350	53.350	53.350		
GAMG 2A	1.40000	1.40000	1.40000	1.40000	1.40000		
RWG 2A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2A	6.21734	7.46048	8.67619	10.00385	11.25376	43.61162	TOTAL FLOW

B. Wet-Vapor Potassium Turbine* (5 Radial Sectors)

1. Calculation of Modified Parameters

Using the equations given in Section IV, the values for the modified parameters (given in Table I B-1) were calculated by hand and used as data input to the modified NASA turbine code. Only the 5th and 6th stages are analyzed and correspond to stages 1 and 2 in the output listing.

2. Comparison of Results from Modified NASA Code and WSD Code

Table I B-2 shows a comparison of the results between the 1-D and 2-D codes from WSD and the NASA code using the modified parameters. The total-to-static pressure ratio (PTPS) across the first stator was adjusted until the turbine exit conditions were identical to those obtained in the Steam Division codes. The modified parameters were assumed to remain constant during the small changes in PTPS. Unfortunately, a completely consistent set of input data was impossible to be obtained from either Table I or Table II of Reference (2) or a combination of the two. The difference in the 2-D blade angle distribution from that used in the 1-D calculation is most likely the primary reason that the jet velocities at the mean diameters are not in better agreement.

Figures I B-1 and I B-2 show the slight differences in the angles used in Fentress 2-D calculations and those used as input to the NASA code 2-D analysis. Figure I B-3 shows the good agreement between the turbine exit jet velocities as calculated by both codes. In Figure I B-4, there is also good agreement with the static pressure distributions from the 5th stator exit.

It is therefore concluded that if one performs a hand solution (or uses an appropriate computer code) for a 1-D turbine analysis, then this method of using modified γ, R, and η parameters with the NASA code will give a valid and thermodynamically consistent two-dimensional analysis of a turbine operating in the wet vapor region.

* Described in Reference (2).

TABLE I B-1

MODIFIED PARAMETERS FOR POTASSIUM TURBINE

Station	D_R^*	D_T^*	R*	γ*	η*	
0	5.29	7.51	31.158	1.1825	---	P_{T0}^* = 38.828; PTPS = 1.3619
1	5.15	7.83	30.842	1.1437	0.92577	
1A	5.15	7.83	30.842	1.1437	---	
2	5.04	8.28	30.689	1.16607	0.81662	
2A	5.04	8.28	30.689	1.16607	---	
0	5.04	8.28	30.689	1.16607	---	
1	4.88	8.62	30.828	1.1447	0.94752	
1A	4.88	8.62	30.828	1.1447	---	
2	4.60	9.10	30.763	1.1637	0.8155	
2A	4.60	9.10	30.763	1.1637	---	

TABLE IB-2

COMPARISON OF POTASSIUM TURBINE DATA AT MEAN DIAMETER

Blade Row Exit Conditions	Fourth Rotor			Fifth Stator			Fifth Rotor		
	Ⓦ1-D Code (1)	NASA Code (2)	% Difference	Ⓦ1-D Code (1)	NASA Code (2)	% Difference	Ⓦ1-D Code (1)	NASA Code (2)	% Difference
Blade height (inch)	1.11	1.11 *	0.0	1.34	1.34 *	0.0	1.62	1.62 *	0.0
Mean diameter (inch)	6.40	6.40 *	0.0	6.49	6.49 *	0.0	6.66	6.66 *	0.0
Flow angle (degree)	64.37	--	--	64.37(65.03)	65.03 *	+1.03(0.0)	64.37(63.65)	63.65 *	-1.12(0.0)
Static pressure (psia)	37.00	--	--	28.51	28.198	-1.09	22.04	21.963	-0.349
Static temperature (^{o}R)	2052	--	--	1994	1991.9	-0.105	1937	1936.7	-0.015
Flow rate (lb/sec)	5.76	--	--	5.76	5.75951	0.0	5.76	5.75951	0.0
Jet velocity (ft/sec)	1034	--	--	1049(1076.5)	1091.3	+4.03(+1.37)	1075(1033.5)	1028.4	-4.33(-0.496)
Gamma	1.211	1.1825*	--	1.203	1.1437*	--	1.196	1.16607*	--
Gas constant (ft/^{o}R)	31.51	31.158*	--	31.23	30.842*	--	30.93	30.689*	--
Efficiency Coefficient for Blade Row	--	--	--	--	0.92577	--	--	0.81662*	--

Blade Row Exit Conditions	Sixth Stator			Sixth Rotor		
	Ⓦ1-D Code (1)	NASA Code (2)	% Difference	Ⓦ1-D Code (1)	NASA Code (2)	% Difference
Blade height (inch)	1.87	1.87 *	0.0	2.25	2.25 *	0.0
Mean diameter (inch)	6.75	6.75 *	0.0	6.85	6.85 *	0.0
Flow angle (degree)	57.32(57.57)	57.57 *	+0.436(0.0)	60.30(58.98)	58.98 *	-2.19(0.0)
Static pressure (psia)	19.69	19.495	-0.990	16.90	16.892	-0.047
Static temperature (^{o}R)	1914	1911.9	-0.110	1882	1882.0	0.0
Flow rate (lb/sec)	5.76	5.75951	0.0	5.76	5.75951	0.0
Jet velocity (ft/sec)	815(811.7)	823.0	+0.982(-1.39)	822(790.6)	779.9	-4.77(-1.35)
Gamma	1.195	1.1447*	--	1.194	1.1637*	--
Gas constant (ft/^{o}R)	30.80	30.828*	--	30.65	30.763*	--
Efficiency Coefficient for Blade Row	--	0.94752*	--	--	0.8155*	--

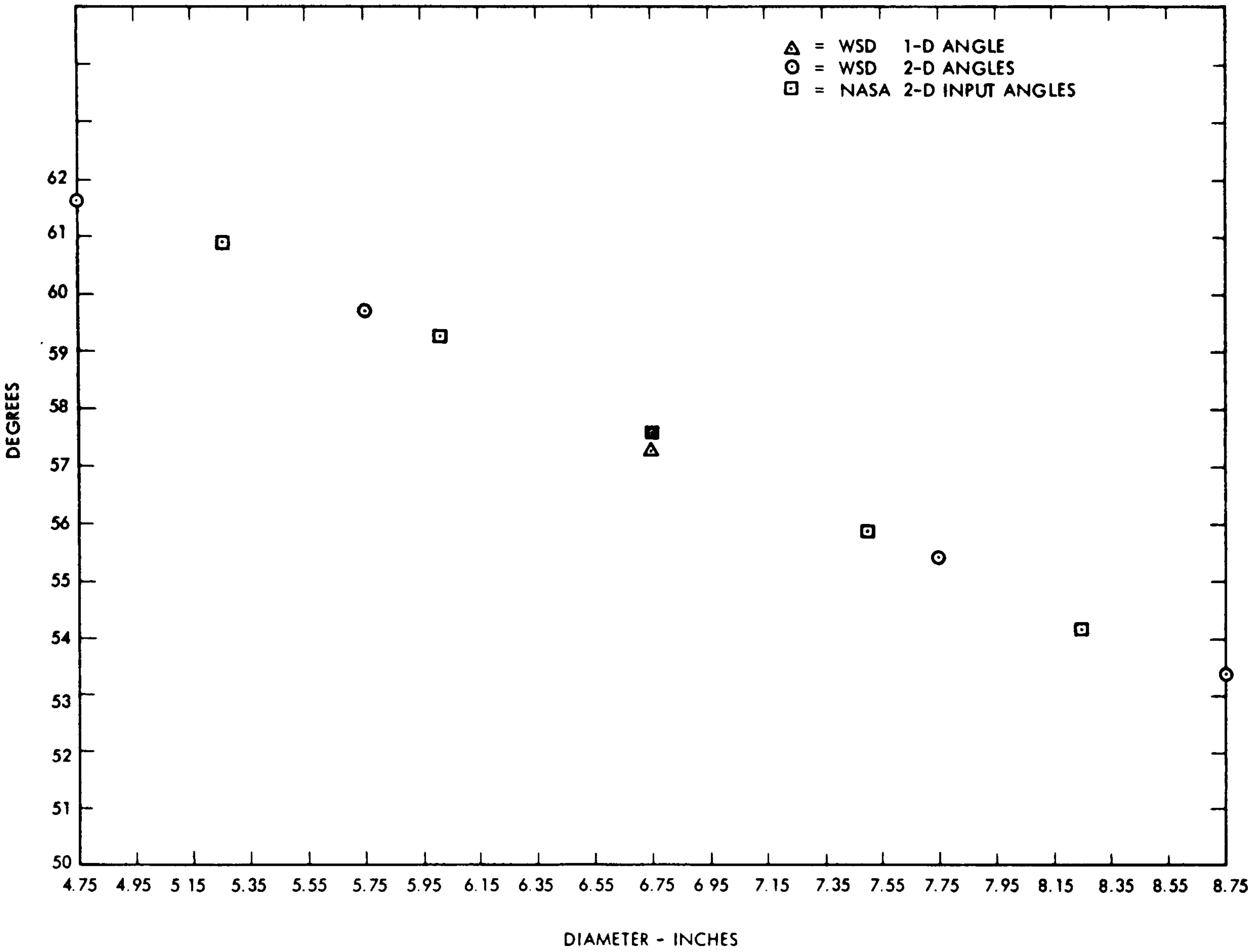
(1) From Reference (2)

(2) Using modified NASA Code (5 radial sectors)

Terms in parentheses are from Ⓦ 2-D code. See Reference (2)

Flow angles are with respect to axial direction

* Indicates NASA code input data.



TD 963

Figure I B-1. 6th Stator Blade Exit Angles

Astronuclear Laboratory

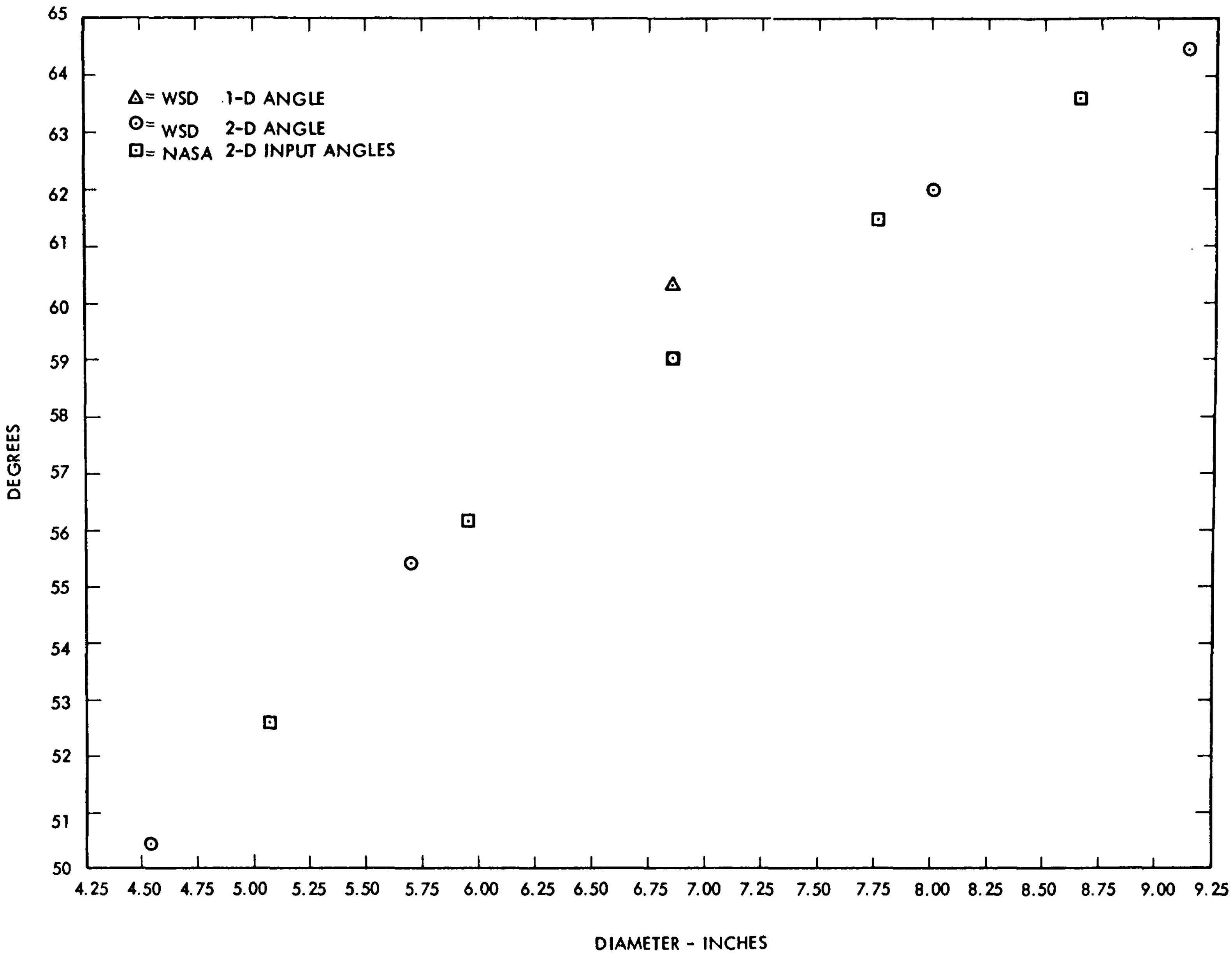


Figure I B-2. 6th Rotor Blade Exit Angles

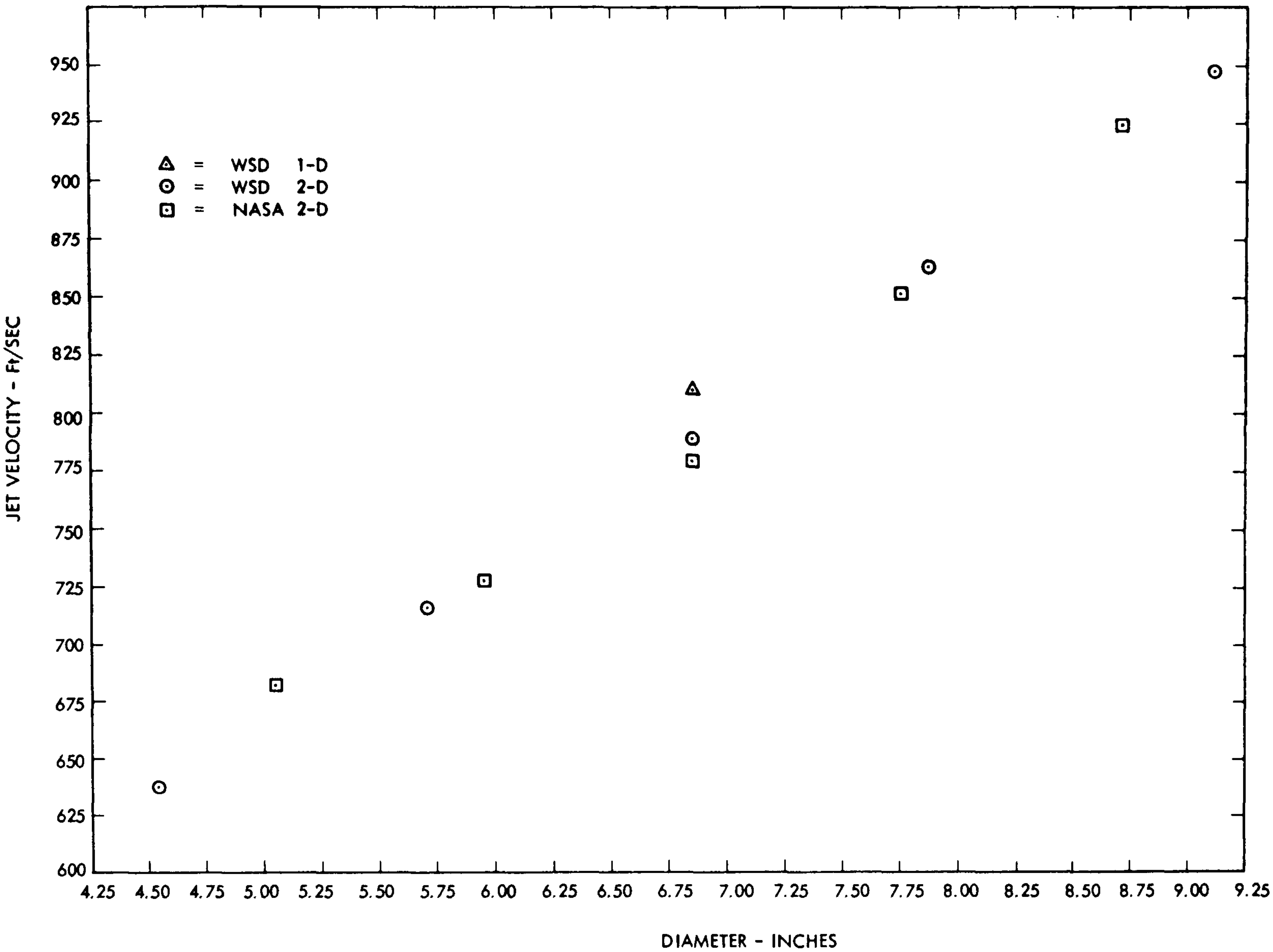


Figure I B-3. 6th Rotor Exit Jet Velocity

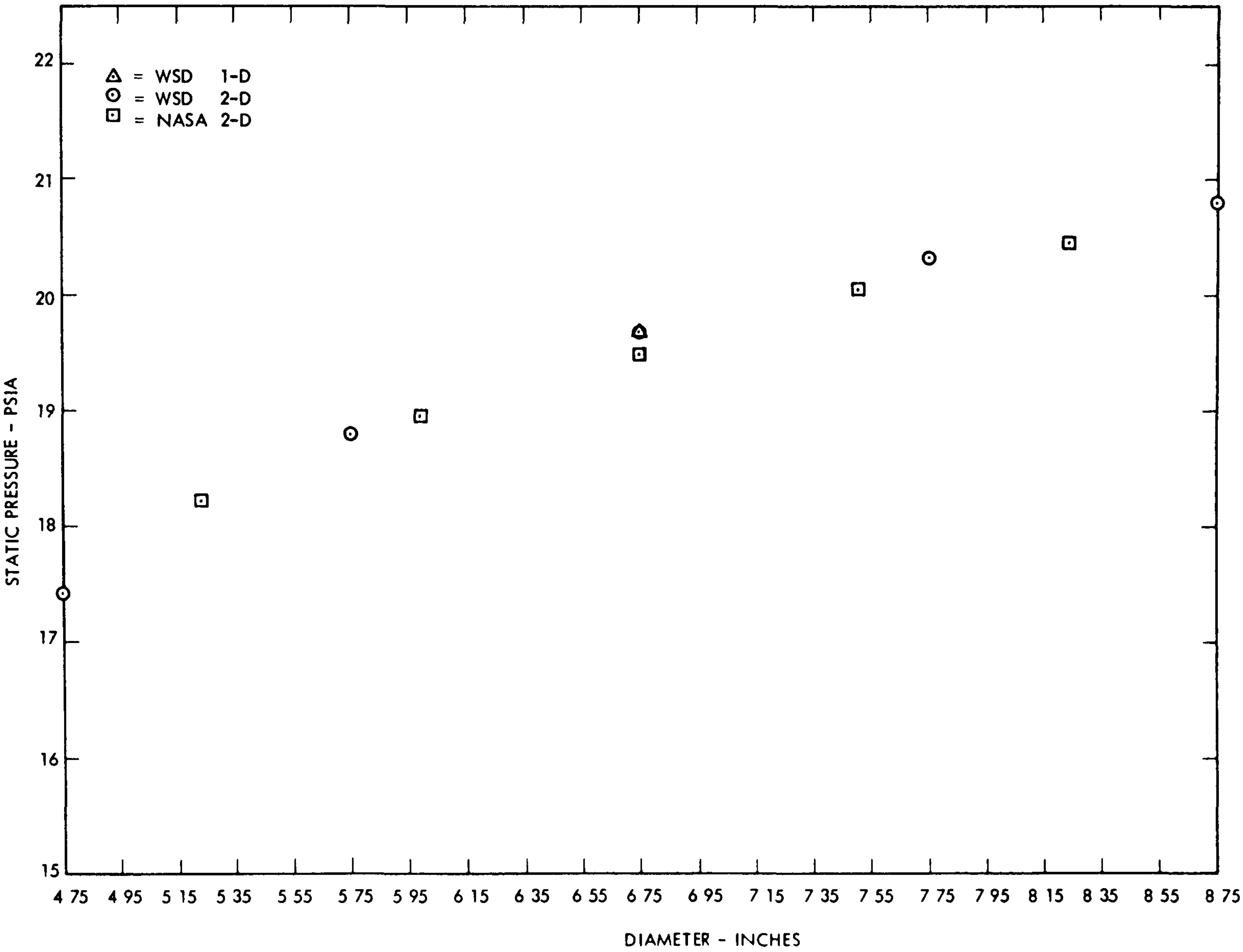


Figure I B-4. 5th Stator Exit Static Pressure

3. Data Input

```
                          TURBINE COMPUTER PROGRAM
   TWO STAGE POTASSIUM TURBINE
   FIVE RADIAL SECTORS
$DATAIN
 STGCH=      1.000
  TTIN=   2067.300   PTIN=     38.828   WAIR=      0.000  FAIR=       0.000
  PTPS=      1.377   DELC=      0.000   DELL=      0.000  DELA=       0.000
   STG=      2.000   SECT=      5.000   EXPN=      0.000  EXPP=       0.000
   PAF=      1.000    SLI=      0.000   AACS=      1.000   RPM=   24000.000
  VCTD=      1.000    RSL=     37.600    TSL=   1800.000   PSL=      11.200
 GAMSL=      1.618 ENDSTG=      0.000 ENDJOB=      0.000

                          INLET RADIAL PROFILES
  PCNH=     .200        .200        .200        .200        .200      0.000

                              STANDARD OPTION
 STAGE=   1                   AXIAL STATIONS
          STA. 0      STA. 1      STA.1A      STA. 2      STA.2A
    RG=   31.158      30.842      30.842      30.689      30.689      0.000
  GAMG=    1.182       1.144       1.144       1.166       1.166      0.000
    DR=    5.290       5.150       5.150       5.040       5.040      0.000
    DT=    7.510       7.830       7.830       8.280       8.280      0.000
   RWG=    1.000       1.000       1.000       1.000       1.000      0.000

                        STATOR RADIAL DISTRIBUTIONS
            ROOT                  PITCH                   TIP
  SDIA=    0.000       0.000       0.000       0.000       0.000      0.000
  SDEA=   66.100      65.600      65.030      64.350      63.650      0.000
  SREC=    1.000       1.000       1.000       1.000       1.000      0.000
  SETA=     .926        .926        .926        .926        .926      0.000
   SCF=    1.000       1.000       1.000       1.000       1.000      0.000
   SPA=    0.000       0.000       0.000       0.000       0.000      0.000
 SESTH=    1.000

                        ROTOR RADIAL DISTRIBUTIONS
  RDIA=   48.850      41.500      33.060      22.000       8.500      0.000
  RDEA=   61.600      62.650      63.650      64.550      65.350      0.000
  RREC=    1.000       1.000       1.000       1.000       1.000      0.000
  RETA=     .817        .817        .817        .817        .817      0.000
   RCF=    1.000       1.000       1.000       1.000       1.000      0.000
   RPA=    0.000       0.000       0.000       0.000       0.000      0.000
   RTF=    1.000       1.000       1.000       1.000       1.000      0.000
 RERTH=    1.000

                              STANDARD OPTION
 STAGE=   2                   AXIAL STATIONS
          STA. 0      STA. 1      STA.1A      STA. 2      STA.2A
    RG=   30.689      30.828      30.828      30.763      30.763      0.000
  GAMG=    1.166       1.145       1.145       1.164       1.164      0.000
    DR=    5.040       4.880       4.880       4.600       4.600      0.000
    DT=    8.280       8.620       8.620       9.100       9.100      0.000
   RWG=    1.000       1.000       1.000       1.000       1.000      0.000

                        STATOR RADIAL DISTRIBUTIONS
            ROOT                  PITCH                   TIP
  SDIA=   32.300      29.700      26.540      23.400      20.000      0.000
  SDEA=   60.900      59.250      57.570      55.850      54.150      0.000
  SREC=    1.000       1.000       1.000       1.000       1.000      0.000
  SETA=     .948        .948        .948        .948        .948      0.000
   SCF=    1.000       1.000       1.000       1.000       1.000      0.000
   SPA=    0.000       0.000       0.000       0.000       0.000      0.000

 SESTH=    1.000

                        ROTOR RADIAL DISTRIBUTIONS
  RDIA=   32.800      16.000      -2.860     -20.500     -35.000      0.000
  RDEA=   52.600      56.100      58.980      61.450      63.600      0.000
  RREC=    1.000       1.000       1.000       1.000       1.000      0.000
  RETA=     .816        .816        .816        .816        .816      0.000
   RCF=    1.000       1.000       1.000       1.000       1.000      0.000
   RPA=    0.000       0.000       0.000       0.000       0.000      0.000
   RTF=    1.000       1.000       1.000       1.000       1.000      0.000
 RERTH=    1.000
```

4. Listing of Data Output

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
FIVE RADIAL SECTORS

CASE 2. 0

STAGE PERFORMANCE

	STAGE 1	STAGE 2	STAGE 3	STAGE 4
TTBAR 0	2067.3	1955.8		
PTBAR 0	38.828	23.524		
WG 0	5.758	5.758		
DEL H	32.871	17.954		
WRT/P	6.743	10.825		
DH/TTBARO	.01590	.00918		
N/RT	527.849	542.687		
ETA TT	.82986	.82761		
ETA TS	.73329	.71650		
ETA AT	.80877	.82531		
PTO/PS1	1.377	1.205		
PTBARO/PTBAR2	1.651	1.331		
PTBARO/PS2	1.768	1.393		
PTR2/PS2	1.396	1.219		
TTBAR2/TTBARO	.94606	.96900		
TTR1A/TTBARO	.97296	.98369		
WG 1	5.758	5.758		
PS 1A	26.198	19.495		
TTR 1A	2011.4	1924.3		
PTR 1A	30.472	20.520		
WG 1A	5.758	5.758		
PS 2	21.963	16.892		
TTBAR 2	1955.8	1895.2		
PTBAR 2	23.524	17.676		
WG 2	5.758	5.758		
WG 2A	5.758	5.758		
UP/VI	.45953	.63693		
UR/VI	.35610	.44398		
PSI P	.86799	.44324		
PSI R	1.44550	.91223		
RX P	.42914	.42908		
RX R	.20904	.12560		
ALPHA 0	0.000	26.147		
I STATOR	0.000	-.393		
BETA 1A	33.910	-1.584		
I ROTOR	.850	1.276		
ALPHA 2A	26.147	-6.951		
DBETA R	109.973	84.948		
M 1	.72584	.55860		
M1 RT	.86583	.70312		
MR 1A	.36920	.29968		
MR1A RT	.55090	.42459		
MR 2	.68866	.52969		
MR2 TIP	.75376	.65843		
E/TH CR	39.397	23.242		
N/RTH CR	26274.6	27306.5		
WRTHCRE/D	1.806	2.893		

OVERALL PERFORMANCE

PSI P	.64847	PSI R	1.19809	DEL H	50.82569
WRT/P	6.74307	N/RT	527.84874	DELH/TTIN	.02459
PTO/PTBAR2	2.19659	PTO/PS2	2.29857	PTO/PAT2A	2.20133
ETA TT	.83219	ETA TS	.78924	ETA TAT	.83138
WNE/60D	791.002	N/RTH CR	26274.585	E/TH CR	60.91617

4. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
FIVE RADIAL SECTORS
CASE 2. 0
INTER-STAGE PERFORMANCE

STA 1A	ROTOR INLET		STAGE 1.				
DIAM 1A	5.418	5.954	6.490	7.026	7.562		
PTR 1A	29.654	30.037	30.472	31.095	31.763		
TTR 1A	2006.4	2008.6	2011.4	2015.7	2020.5		
BETA 1A	48.373	42.053	33.910	22.748	9.389		
I ROTOR	-.477	.553	.850	.748	.889		
R 1A	754.950	644.729	555.112	479.687	433.031		
RU 1A	564.315	431.849	309.689	185.482	70.646		
MR 1A	.50486	.42985	.36920	.31830	.28681		
U 1A	567.371	623.501	679.631	735.760	791.890		
PS 1A	25.666	27.044	28.198	29.351	30.308		
TS 1A	1970.3	1982.3	1991.9	2001.2	2008.6		
CP 1A	.31545	.31545	.31545	.31545	.31545		
RG 1A	30.842	30.842	30.842	30.842	30.842		
GAMG 1A	1.14370	1.14370	1.14370	1.14370	1.14370		
RWG 1A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1A	.96621	1.06158	1.15544	1.24444	1.33073	5.75839	TOTAL FLOW
STA 2	ROTOR EXIT						
DIAM 2	5.364	6.012	6.660	7.308	7.956		
PTR 2	29.607	30.095	30.660	31.441	32.298		
TTR 2	2006.0	2009.1	2013.0	2018.6	2024.8		
BETA 2	61.600	62.650	63.650	64.550	65.350		
DBETA	109.973	104.703	97.560	87.298	74.739		
R 2	982.663	1002.932	1028.350	1063.272	1100.854		
RU 2	864.397	890.820	921.504	960.092	1000.536		
MR 2	.65812	.67166	.68866	.71198	.73709		
U 2	561.716	629.575	697.433	765.291	833.150		
RX	.27374	.35918	.42914	.49716	.55252		
DELH	32.437	32.851	33.097	33.027	32.852		
PSI P	2.54805	2.09519	1.74763	1.46741	1.24504		
ETA TT	.82775	.83218	.83334	.83074	.82585		
ETA TS	.71574	.72958	.73822	.73985	.73811		
ETA AT	.79117	.80466	.81300	.81534	.81449		
ZWI INC	-1.34588	-1.19694	-1.06034	-.93090	-.81566		
CP R	.40976	.58675	.70861	.79647	.84527		
PS 2	21.823	21.907	21.963	22.019	22.058		
TS 2	1936.3	1936.5	1936.7	1937.0	1937.4		
CP 2	.27692	.27692	.27692	.27692	.27692		
RG 2	30.689	30.689	30.689	30.689	30.689		

4. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
FIVE RADIAL SECTORS
CASE 2. 0
INTER-STAGE PERFORMANCE

STA 0	STATOR INLET		STAGE 1.				
DIAM 0	5.512	5.956	6.400	6.844	7.288		
TT 0	2067.3	2067.3	2067.3	2067.3	2067.3		
PT 0	38.828	38.828	38.828	38.828	38.828		
ALPHA 0	0.000	0.000	0.000	0.000	0.000		
I STATOR	0.000	0.000	0.000	0.000	0.000		
V 0	447.396	447.396	447.396	447.396	447.396		
VU 0	0.000	0.000	0.000	0.000	0.000		
VZ 0	447.396	447.396	447.396	447.396	447.396		
TS 0	2051.9	2051.9	2051.9	2051.9	2051.9		
PS 0	36.991	36.991	36.991	36.991	36.991		
DENS 0	.08332	.08332	.08332	.08332	.08332		
M 0	.28686	.28686	.28686	.28686	.28686		
CP 0	.25944	.25944	.25944	.25944	.25944		
RG 0	31.158	31.158	31.158	31.158	31.158		
GAMG 0	1.18250	1.18250	1.18250	1.18250	1.18250		
RWG 0	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 0	.96621	1.06158	1.15544	1.24444	1.33073	5.75839	TOTAL FLOW
STA 1	STATOR EXIT						
DIAM 1	5.418	5.954	6.490	7.026	7.562		
ALPHA 1	66.100	65.600	65.030	64.350	63.650		
DEL A	66.100	65.600	65.030	64.350	63.650		
V 1	1237.825	1158.855	1091.327	1021.951	962.546		
VU 1	1131.686	1055.350	989.319	921.243	862.536		
VZ 1	501.495	478.729	460.698	442.375	427.230		
TS 1	1970.3	1982.3	1991.9	2001.2	2008.6		
PS 1	25.666	27.044	28.198	29.351	30.308		
DENS 1	.06082	.06370	.06609	.06848	.07045		
M 1	.82778	.77262	.72584	.67812	.63751		
ZWI INC	-.74081	-.75242	-.76537	-.78043	-.79547		
CP S	.86936	.85095	.83194	.80834	.78396		
CP 1	.31545	.31545	.31545	.31545	.31545		
RG 1	30.842	30.842	30.842	30.842	30.842		
GAMG 1	1.14370	1.14370	1.14370	1.14370	1.14370		
RWG 1	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1	.96621	1.06158	1.15544	1.24444	1.33073	5.75839	TOTAL FLOW
GAMG 2	1.16607	1.16607	1.16607	1.16607	1.16607		
RWG 2	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2	.93714	1.03939	1.14342	1.25898	1.37946	5.75839	TOTAL FLOW
PT 2A	23.655	23.566	23.492	23.480	23.473		
TT 2A	1957.3	1955.9	1955.0	1955.3	1955.9		
V 2A	556.829	529.680	506.471	496.706	488.699		
VU 2A	302.681	261.246	224.071	194.801	167.386		
ALPHA 2A	32.928	29.552	26.147	23.091	20.030		
MF 2A	.31302	.30858	.30566	.30596	.30742		
VZ 2A	467.379	460.772	456.437	456.913	459.139		
TS 2A	1936.3	1936.5	1936.7	1937.0	1937.4		
PS 2A	21.823	21.907	21.963	22.019	22.058		
DENS 2A	.05288	.05306	.05321	.05334	.05342		
M 2A	.37293	.35473	.34051	.33260	.32721		
CP 2A	.27692	.27692	.27692	.27692	.27692		
RG 2A	30.689	30.689	30.689	30.689	30.689		
GAMG 2A	1.16607	1.16607	1.16607	1.16607	1.16607		
RWG 2A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2A	.93714	1.03939	1.14342	1.25898	1.37946	5.75839	TOTAL FLOW

4. Output Data (continued)

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                    NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
FIVE RADIAL SECTORS
                              CASE   2.  0
                         INTER-STAGE PERFORMANCE
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STA 0	STATOR INLET		STAGE 2.				
DIAM 0	5.364	6.012	6.660	7.308	7.956		
TT 0	1957.3	1955.9	1955.0	1955.3	1955.9		
PT 0	23.655	23.566	23.492	23.480	23.473		
ALPHA 0	32.928	29.552	26.147	23.091	20.030		
I STATOR	.628	-.148	-.393	-.309	.030		
V 0	556.829	529.680	508.471	496.706	488.699		
VU 0	302.681	261.246	224.071	194.801	167.386		
VZ 0	467.379	460.772	456.437	456.913	459.139		
TS 0	1936.3	1936.5	1936.7	1937.0	1937.4		
PS 0	21.823	21.907	21.963	22.019	22.058		
DENS 0	.05288	.05308	.05321	.05334	.05342		
M 0	.37293	.35473	.34051	.33260	.32721		
CP 0	.27692	.27692	.27692	.27692	.27692		
RG 0	30.689	30.689	30.689	30.689	30.689		
GAMG 0	1.16607	1.16607	1.16607	1.16607	1.16607		
RWG 0	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 0	.93714	1.03939	1.14342	1.25898	1.37946	5.75839	TOTAL FLOW
STA 1	STATOR EXIT						
DIAM 1	5.254	6.002	6.750	7.498	8.246		
ALPHA 1	60.900	59.250	57.570	55.850	54.150		
DEL A	93.828	88.802	83.717	78.941	74.180		
V 1	972.507	889.612	823.007	758.647	707.705		
VU 1	849.749	764.538	694.656	627.834	573.632		
VZ 1	472.965	454.853	441.353	425.875	414.479		
TS 1	1897.0	1905.4	1911.9	1918.6	1923.9		
PS 1	18.215	18.945	19.495	20.045	20.459		
DENS 1	.04485	.04644	.04763	.04880	.04967		
M 1	.66265	.60483	.55860	.51402	.47883		
ZWI INC	-1.15624	-1.17526	-1.18763	-1.19784	-1.19952		
CP S	.67216	.64549	.61830	.57133	.52315		
CP 1	.31340	.31340	.31340	.31340	.31340		
RG 1	30.828	30.828	30.828	30.828	30.828		
GAMG 1	1.14470	1.14470	1.14470	1.14470	1.14470		
RWG 1	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1	.90940	1.03454	1.15778	1.27150	1.38518	5.75840	TOTAL FLOW

4. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
MEAN DIAMETER CALCULATION
CASE 3. 0
INTER-STAGE PERFORMANCE

STA 0	STATOR INLET		STAGE 1.
DIAM 0	5.290	6.400	7.510
TT 0	2067.3	2067.3	2067.3
PT 0	38.828	38.828	38.828
ALPHA 0	0.000	0.000	0.000
I STATOR	0.000	0.000	0.000
V 0	447.396	447.396	447.396
VU 0	0.000	0.000	0.000
VZ 0	447.396	447.396	447.396
TS 0	2051.9	2051.9	2051.9
PS 0	36.991	36.991	36.991
DENS 0	.08332	.08332	.08332
M 0	.28686	.28686	.28686
CP 0	.25944	.25944	.25944
RG 0	31.158	31.158	31.158
GAMG 0	1.18250	1.18250	1.18250
RWG 0	1.00000	1.00000	1.00000
STA 1	STATOR EXIT		
DIAM 1	5.150	6.490	7.830
ALPHA 1	69.720	65.030	60.672
DEL A	69.720	65.030	60.672
V 1	1329.131	1091.327	940.563
VU 1	1246.734	989.319	820.011
VZ 1	460.698	460.698	460.698
TS 1	1955.5	1991.9	2011.3
PS 1	24.344	28.198	30.458
DENS 1	.05812	.06609	.07070
M 1	.89220	.72584	.62254
ZWI INC	-.65026	-.76537	-.65406
CP S	.88670	.83194	.77374
CP 1	.31545	.31545	.31545
RG 1	30.842	30.842	30.842
GAMG 1	1.14370	1.14370	1.14370
RWG 1	1.00000	1.00000	1.00000

C. Wet-Vapor Potassium Turbine * (Mean Diameter Calculation)

1. Comparison of Results

The same modified parameters given in Table I B-1 are used in the one radial sector (mean diameter) calculation. The results are in good agreement with the 5 radial sector calculation as can be seen by comparing the calculated parameters at the mean diameter. In the single sector case the hub and tip values are calculated assuming a free vortex distribution.** There is a slight inconsistency in the results in that P_S, T_S, ρ, and M for station 0 of the second stage are not identical to those at station 2A of the first stage. The discrepancies are small and thought not to be significant. At this time there is no explanation for this anomaly. The output format for the mean diameter case is slightly different from that using 5 radial sectors.

2. Data Input

```
                         TURBINE COMPUTER PROGRAM
    TWO STAGE POTASSIUM TURBINE
    MEAN DIAMETER CALCULATION
$DATAIN
 STGCH=      1.000
  TTIN=   2067.300    PTIN=      38.828    WAIR=       0.000  FAIR=       0.000
  PTPS=      1.377    DELC=       0.000    DELL=       0.000  DELA=       0.000
   STG=      2.000    SECT=       1.000    EXPN=       0.000  EXPP=       0.000
   PAF=      1.000     SLI=       0.000    AACS=       1.000   RPM=   24000.000
  VCTO=      1.000     RSL=      37.600     TSL=    1800.000   PSL=      11.200
 GAMSL=      1.618  ENDSTG=       0.000  ENDJOB=       0.000

                         INLET RADIAL PROFILES
  PCNH=    1.000      0.000      0.000      0.000      0.000      0.000
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* Described in Reference (2)

** Assumes a constant axial velocity component

2. Data Input (continued)

STANDARD CPTION

STAGE= 1

AXIAL STATIONS

	STA. 0	STA. 1	STA.1A	STA. 2	STA.2A	
RG=	31.158	30.842	30.842	30.689	30.689	0.000
GAMG=	1.182	1.144	1.144	1.166	1.166	0.000
DR=	5.290	5.150	5.150	5.040	5.040	0.000
DT=	7.510	7.830	7.830	8.280	8.280	0.000
RWG=	1.000	1.000	1.000	1.000	1.000	0.000

STATOR RADIAL DISTRIBUTIONS

	ROOT		PITCH		TIP	
SDIA=	0.000	0.000	0.000	0.000	0.000	0.000
SDEA=	65.030	0.000	0.000	0.000	0.000	0.000
SREC=	1.000	0.000	0.000	0.000	0.000	0.000
SETA=	.926	0.000	0.000	0.000	0.000	0.000
SCF=	1.000	0.000	0.000	0.000	0.000	0.000
SPA=	0.000	0.000	0.000	0.000	0.000	0.000
SESTH=	1.000					

ROTOR RADIAL DISTRIBUTIONS

RDIA=	33.060	0.000	0.000	0.000	0.000	0.000
RDEA=	63.650	0.000	0.000	0.000	0.000	0.000
RREC=	1.000	0.000	0.000	0.000	0.000	0.000
RETA=	.817	0.000	0.000	0.000	0.000	0.000
RCF=	1.000	0.000	0.000	0.000	0.000	0.000
RPA=	0.000	0.000	0.000	0.000	0.000	0.000
RTF=	1.000	0.000	0.000	0.000	0.000	0.000
RERTH=	1.000					

STANDARD CPTION

STAGE= 2

AXIAL STATIONS

	STA. 0	STA. 1	STA.1A	STA. 2	STA.2A	
RG=	30.689	30.828	30.828	30.763	30.763	0.000
GAMG=	1.166	1.145	1.145	1.164	1.164	0.000
DR=	5.040	4.880	4.880	4.600	4.600	0.000
DT=	8.280	8.620	8.620	9.100	9.100	0.000
RWG=	1.000	1.000	1.000	1.000	1.000	0.000

STATOR RADIAL DISTRIBUTIONS

	ROOT		PITCH		TIP	
SDIA=	26.540	0.000	0.000	0.000	0.000	0.000
SDEA=	57.570	0.000	0.000	0.000	0.000	0.000
SREC=	1.000	0.000	0.000	0.000	0.000	0.000
SETA=	.948	0.000	0.000	0.000	0.000	0.000
SCF=	1.000	0.000	0.000	0.000	0.000	0.000
SPA=	0.000	0.000	0.000	0.000	0.000	0.000
SESTH=	1.000					

ROTOR RADIAL DISTRIBUTIONS

RDIA=	-2.860	0.000	0.000	0.000	0.000	0.000
RDEA=	58.980	0.000	0.000	0.000	0.000	0.000
RREC=	1.000	0.000	0.000	0.000	0.000	0.000
RETA=	.816	0.000	0.000	0.000	0.000	0.000
RCF=	1.000	0.000	0.000	0.000	0.000	0.000
RPA=	0.000	0.000	0.000	0.000	0.000	0.000
RTF=	1.000	0.000	0.000	0.000	0.000	0.000
RERTH=	1.000					

3. Listing of Data Output

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
MEAN DIAMETER CALCULATION
CASE 3. 0
STAGE PERFORMANCE

	STAGE 1	STAGE 2	STAGE 3	STAGE 4
TTBAR 0	2067.3	1952.6		
PTBAR 0	38.828	23.187		
WG 0	5.777	5.777		
DEL H	33.818	19.562		
WRT/P	6.765	11.010		
DH/TTBAR0	.01636	.01002		
N/RT	527.849	543.133		
ETA TT	.83062	.83613		
ETA TS	.73030	.72533		
ETA AT	.80615	.83602		
PT0/PS1	1.377	1.212		
PTBAR0/PTBAR2	1.675	1.362		
PTBAR0/PS2	1.803	1.430		
PTR2/PS2	1.423	1.248		
TTBAR2/TTBAR0	.94451	.96618		
TTR1A/TTBAR0	.97296	.98377		
WG 1	5.777	5.777		
PS 1A	28.198	19.126		
TTR 1A	2011.4	1920.9		
PTR 1A	30.472	20.164		
WG 1A	5.777	5.777		
PS 2	21.540	16.219		
TTBAR 2	1952.6	1886.5		
PTBAR 2	23.187	17.022		
WG 2	5.777	5.777		
WG 2A	5.777	5.777		
UP/VI	.45217	.61276		
UR/VI	.35039	.42713		
PSI P	.89299	.48294		
PSI R	1.48713	.99392		
RX P	.44730	.45539		
RX R	.18072	.10147		
ALPHA 0	0.000	28.042		
I STATOR	0.000	1.502		
BETA 1A	33.910	-.209		
I ROTOR	.850	2.651		
ALPHA 2A	28.042	-1.642		
DBETA R	97.560	58.771		
M 1	.72584	.56766		
M1 RT	.89220	.73490		
MR 1A	.36920	.30442		
MR1A RT	.56669	.44181		
MR 2	.70879	.56012		
MR2 TIP	.78183	.70431		
E/TH CR	40.532	25.366		
N/RTH CR	26274.6	27329.0		
WRTHCRE/D	1.812	2.942		

OVERALL PERFORMANCE

PSI P	.68107	PSI R	1.25831	DEL H	53.38050
WRT/P	6.76508	N/RT	527.84874	DELH/TTIN	.02582
PT0/PTBAR2	2.28102	PT0/PS2	2.39404	PT0/PAT2A	2.28112
ETA TT	.83611	ETA TS	.79231	ETA TAT	.83607
WNE/60D	793.584	N/RTH CR	26274.585	E/TH CR	63.97818

3. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
FIVE RADIAL SECTORS
CASE 2. 0
INTER-STAGE PERFORMANCE

STA 1A	ROTOR INLET		STAGE 2.				
DIAM 1A	5.254	6.002	6.750	7.498	8.246		
PTR 1A	19.788	20.105	20.520	21.156	21.871		
TTR 1A	1917.0	1919.8	1924.3	1931.7	1940.2		
BETA 1A	32.348	16.648	-1.584	-20.279	-34.969		
I ROTOR	-.452	.648	1.276	.221	.031		
R 1A	559.846	474.753	441.522	454.016	505.793		
RU 1A	299.552	136.010	-12.202	-157.354	-289.886		
MR 1A	.38147	.32277	.29968	.30762	.34222		
U 1A	550.197	628.527	706.858	785.188	863.518		
PS 1A	18.215	18.945	19.495	20.045	20.459		
TS 1A	1897.0	1905.4	1911.9	1918.6	1923.9		
CP 1A	.31340	.31340	.31340	.31340	.31340		
RG 1A	30.828	30.828	30.828	30.828	30.828		
GAMG 1A	1.14470	1.14470	1.14470	1.14470	1.14470		
RWG 1A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 1A	.90940	1.03454	1.15778	1.27150	1.38518	5.75840	TOTAL FLOW
STA 2	ROTOR EXIT						
DIAM 2	5.050	5.950	6.850	7.750	8.650		
PTR 2	19.669	20.069	20.600	21.390	22.300		
TTR 2	1915.5	1919.4	1925.2	1934.4	1945.0		
BETA 2	52.600	56.100	58.980	61.450	63.600		
DBETA	84.948	72.748	57.396	41.171	28.631		
R 2	682.758	726.616	779.865	851.208	924.085		
RU 2	542.393	603.100	668.334	747.701	827.713		
MR 2	.46369	.49354	.52969	.57800	.62726		
U 2	528.834	623.082	717.330	811.577	905.825		
RX	.22043	.33978	.42908	.51389	.57638		
DELH	18.960	18.696	18.208	17.619	16.959		
PSI P	1.63020	1.19519	.89898	.69187	.54219		
ETA TT	.85797	.85186	.83888	.81776	.79218		
ETA TS	.74297	.74135	.72943	.70720	.68159		
ETA AT	.85783	.85155	.83705	.81470	.78772		
ZWI INC	-1.43231	-1.11191	-.86859	-.67083	-.51999		
CP R	.32764	.57310	.67947	.71551	.70041		
PS 2	16.889	16.889	16.892	16.895	16.899		
TS 2	1882.4	1881.8	1882.0	1882.9	1884.3		
CP 2	.28103	.28103	.28103	.28103	.28103		
RG 2	30.763	30.763	30.763	30.763	30.763		
GAMG 2	1.16370	1.16370	1.16370	1.16370	1.16370		
RWG 2	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2	.86346	.99454	1.13553	1.30005	1.46480	5.75839	TOTAL FLOW
PT 2A	17.685	17.650	17.650	17.679	17.708		
TT 2A	1893.3	1892.7	1893.6	1895.8	1898.6		
V 2A	414.913	405.759	404.869	411.799	418.240		
VU 2A	13.559	-19.982	-48.996	-63.877	-78.112		
ALPHA 2A	1.873	-2.823	-6.951	-8.924	-10.764		
MF 2A	.28163	.27527	.27297	.27624	.27890		
VZ 2A	414.691	405.267	401.894	406.814	410.881		
TS 2A	1882.4	1881.8	1882.0	1882.9	1884.3		
PS 2A	16.889	16.889	16.892	16.895	16.899		
DENS 2A	.04200	.04201	.04201	.04200	.04198		
M 2A	.28178	.27561	.27499	.27963	.28390		
CP 2A	.28103	.28103	.28103	.28103	.28103		
RG 2A	30.763	30.763	30.763	30.763	30.763		
GAMG 2A	1.16370	1.16370	1.16370	1.16370	1.16370		
RWG 2A	1.00000	1.00000	1.00000	1.00000	1.00000		
WG 2A	.86346	.99454	1.13553	1.30005	1.46480	5.75839	TOTAL FLOW

3. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
MEAN DIAMETER CALCULATION
CASE 3. 0
INTER-STAGE PERFORMANCE

STA 1A	ROTOR INLET		STAGE 1.
DIAM 1A	5.150	6.490	7.830
PTR 1A	29.190	30.472	32.116
TTR 1A	2000.6	2011.4	2024.7
BETA 1A	56.927	33.910	.007
I ROTOR	.291	.850	1.473
R 1A	844.214	555.112	460.698
RU 1A	707.428	309.689	.056
MR 1A	.56669	.36920	.30493
U 1A	539.306	679.631	819.955
PS 1A	24.344	28.198	30.458
TS 1A	1955.5	1991.9	2011.3
CP 1A	.31545	.31545	.31545
RG 1A	30.842	30.842	30.842
GAMG 1A	1.14370	1.14370	1.14370
RWG 1A	1.00000	1.00000	1.00000

STA 2	ROTOR EXIT		
DIAM 2	5.040	6.660	8.280
BETA 2	61.327	63.650	66.283
DBETA	118.254	97.560	66.290
R 2	977.999	1057.223	1166.653
RU 2	858.070	947.377	1068.121
MR 2	.65625	.70879	.78183
U 2	527.787	697.433	867.079
RX	.21685	.44730	.57436
DELH	33.818	33.818	33.818
PSI P	2.97392	1.78568	1.18905
ETA TT	.83062	.83062	.83062
ETA TS	.73030	.73030	.73030
ETA AT	.80615	.80615	.80615
ZWI INC	-1.54897	-1.06034	-.73654
CP R	.25488	.72431	.84406
PS 2	21.278	21.540	21.664
TS 2	1929.0	1932.4	1933.9
CP 2	.27692	.27692	.27692
RG 2	30.689	30.689	30.689
GAMG 2	1.16607	1.16607	1.16607
RWG 2	1.00000	1.00000	1.00000
PT 2A	23.187	23.187	23.187
TT 2A	1952.6	1952.6	1952.6
V 2A	573.834	531.667	510.506
VU 2A	330.283	249.944	201.042
ALPHA 2A	35.140	28.042	23.192
MF 2A	.31487	.31460	.31447
VZ 2A	469.253	469.253	469.253
TS 2A	1929.0	1932.4	1933.9
PS 2A	21.278	21.540	21.664
DENS 2A	.05176	.05230	.05256
M 2A	.38505	.35644	.34212
CP 2A	.27692	.27692	.27692
RG 2A	30.689	30.689	30.689
GAMG 2A	1.16607	1.16607	1.16607
RWG 2A	1.00000	1.00000	1.00000

3. Output Data (continued)

```
                    NASA TURBINE COMPUTER PROGRAM
 TWO STAGE POTASSIUM TURBINE
 MEAN DIAMETER CALCULATION
                                 CASE    3.  0
                          INTER-STAGE PERFORMANCE


    STA 0   STATOR INLET               STAGE  2.
   DIAM 0         5.040       6.660       8.280
     TT 0        1952.6      1952.6      1952.6
     PT 0        23.187      23.187      23.187
  ALPHA 0        35.140      28.042      23.192
I STATOR          1.715       1.502       1.305
      V 0       573.834     531.667     510.506
     VU 0       330.283     249.944     201.042
     VZ 0       469.253     469.253     469.253
     TS 0        1928.8      1932.4      1933.8
     PS 0        21.266      21.540      21.652
   DENS 0        .05173      .05230      .05254
      M 0        .38506      .35644      .34213
     CP 0        .27692      .27692      .27692
     RG 0        30.689      30.689      30.689
   GAMG 0       1.16607     1.16607     1.16607
    RWG 0       1.00000     1.00000     1.00000

    STA 1   STATOR EXIT
   DIAM 1         4.880       6.750       8.620
  ALPHA 1        65.329      57.570      50.945
    DEL A       100.469      85.612      74.137
      V 1      1073.451     835.528     711.146
     VU 1       975.465     705.225     552.235
     VZ 1       448.068     448.068     448.068
     TS 1        1879.2      1908.1      1920.4
     PS 1        16.948      19.126      20.120
   DENS 1        .04213      .04682      .04894
      M 1        .73490      .56766      .48161
  ZWI INC      -1.00388    -1.21163    -1.31870
     CP S        .71424      .59509      .48467
     CP 1        .31340      .31340      .31340
     RG 1        30.828      30.828      30.828
   GAMG 1       1.14470     1.14470     1.14470
    RWG 1       1.00000     1.00000     1.00000
```

3. Output Data (continued)

NASA TURBINE COMPUTER PROGRAM
TWO STAGE POTASSIUM TURBINE
MEAN DIAMETER CALCULATION
CASE 3. 0
INTER-STAGE PERFORMANCE

STA 1A	ROTOR INLET		STAGE 2.
DIAM 1A	4.880	6.750	8.620
PTR 1A	18.936	20.164	21.894
TTR 1A	1905.7	1920.9	1941.0
BETA 1A	46.027	-.209	-38.030
I ROTOR	.940	2.651	2.043
R 1A	645.339	448.071	568.840
RU 1A	464.433	-1.633	-350.448
MR 1A	.44181	.30442	.38524
U 1A	511.032	706.858	902.684
PS 1A	16.948	19.126	20.120
TS 1A	1879.2	1908.1	1920.4
CP 1A	.31340	.31340	.31340
RG 1A	30.828	30.828	30.828
GAMG 1A	1.14470	1.14470	1.14470
RWG 1A	1.00000	1.00000	1.00000
STA 2	ROTOR EXIT		
DIAM 2	4.600	6.850	9.100
BETA 2	47.552	58.980	65.806
DBETA	93.579	58.771	27.776
R 2	628.292	822.853	1034.685
RU 2	463.610	705.175	943.799
MR 2	.42768	.56012	.70431
U 2	481.710	717.330	952.949
RX	.12058	.45539	.59732
DELH	19.562	19.562	19.562
PSI P	1.98611	.96582	.56853
ETA TT	.83613	.83613	.83613
ETA TS	.72533	.72533	.72533
ETA AT	.83602	.83602	.83602
ZWI INC	-1.94035	-.88134	-.48493
CP R	-.05500	.70348	.69775
PS 2	16.218	16.219	16.219
TS 2	1873.7	1873.7	1873.7
CP 2	.28103	.28103	.28103
RG 2	30.763	30.763	30.763
GAMG 2	1.16370	1.16370	1.16370
RWG 2	1.00000	1.00000	1.00000
PT 2A	17.022	17.022	17.022
TT 2A	1886.5	1886.5	1886.5
V 2A	424.434	424.222	424.146
VU 2A	-18.101	-12.155	-9.150
ALPHA 2A	-2.444	-1.642	-1.236
MF 2A	.28865	.28865	.28865
VZ 2A	424.047	424.047	424.047
TS 2A	1873.7	1873.7	1873.7
PS 2A	16.218	16.219	16.219
DENS 2A	.04052	.04052	.04052
M 2A	.28892	.28877	.28872
CP 2A	.28103	.28103	.28103
RG 2A	30.763	30.763	30.763
GAMG 2A	1.16370	1.16370	1.16370
RWG 2A	1.00000	1.00000	1.00000

APPENDIX II

LISTING OF CODE

The asterisks in the identification columns (73—80) indicate that the card has been changed from the original listing given in NASA CR-710. Most of the changes are in format statements so as to make the output nomenclature agree with the names of program variables used in the computer code.

```
      PROGRAM JIM(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
CNTCP                                                                   NTCP 001
C     NASA TURBINE PROGRAM                                              NTCP 002
C                                                                       NTCP 003
      REAL MFSTOP                                                       NTCP 004
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    NTCP 006
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   NTCP 007
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, NTCP 008
     3DELPR,PASS,IPC,LOPC,ISS                                           NTCP 009
C                                                                       NTCP 010
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  NTCP 012
     2EXPP,EXPRE,   RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARNTCP 015
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)NTCP 016
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(NTCP 017
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)NTCP 018
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              NTCP 019
C                                                                       NTCP 020
      REAL MR2,M2     ,MF2                                              NTCP 021
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6NTCP 022
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)        NTCP 023
C                                                                       NTCP 024
      DIMENSION CS(8),CR(8)                                             NTCP 025
C                                                                       NTCP 026
C                                                                       NTCP 027
      CALL SLITE(0)                                                     NTCP 028
      WAIR=0.0                                                          NTCP 029
      FAIR=0.0                                                          NTCP 030
      PTPS=1.02                                                         NTCP 031
      DELC=0.0                                                          NTCP 032
      DELL=0.0                                                          NTCP 033
      DELA=0.0                                                          NTCP 034
      EXPN=2.0                                                          NTCP 035
      EXPP=2.0                                                          NTCP 036
      EXPRE=0.0                                                         NTCP 037
      RV(1,1)=0.0                                                       ********
      PAF=0.0                                                           NTCP 039
      SLI=0.0                                                           NTCP 040
      AACS=1.0                                                          NTCP 041
      SECT=1.0                                                          NTCP 042
      VCTD=0.0                                                          NTCP 043
      WTOL=1.E-04                                                       NTCP 044
```

Listing of Code (continued)

```
      RHOTOL=1.E-04                                                     NTCP 045
      PRTOL=1.E-06                                                      NTCP 046
      PCNH(1)=1.0                                                       NTCP 047
      GAM(1,1)=0.0                                                      NTCP 048
      RWG(1,1)=1.0                                                      NTCP 049
      ETAS(1,1)=0.0                                                     NTCP 050
      ALPHA1(1,1)=0.0                                                   NTCP 051
      ETAH(1,1)=0.0                                                     NTCP 052
      BETA2(1,1)=0.0                                                    NTCP 053
      TRLOOP=0.                                                         NTCP 054
      TRDIAG=0.0                                                        NTCP 055
      G=32.17405                                                        NTCP 056
      AJ=778.161                                                        NTCP 057
      ICASE=0                                                           NTCP 058
    1 PREVER=.FALSE.                                                    NTCP 059
      READ(5,100) SRFLAG                                                ********
  100 FORMAT(1X,L1)                                                     ********
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(1H1,39H AN ENTRY HAS BEEN MADE IN MAIN PROGRAM)            ********
      CALL INIT                                                         NTCP 060
      ISCASE=0                                                          NTCP 061
      IF (PREVER) GO TO 1                                               NTCP 062
      DO 25 I=1,8                                                       NTCP 063
      CS(I)=0.0                                                         NTCP 064
   25 CR(I)=0.0                                                         NTCP 065
      PASS=0                                                            NTCP 066
    2 PRPC=CS(KN)                                                       NTCP 067
      CALL STA01                                                        NTCP 068
      IF (PREVER) GO TO 40                                              NTCP 069
      IF(ICHOKE.NE.0)  GO TO 3                                          NTCP 070
      IF(SCRIT.EQ.1.) SC=SC+1.                                          NTCP 071
    3 CALL STA1A                                                        NTCP 072
      IF (PREVER) GO TO 40                                              NTCP 073
      LOPIN=0                                                           NTCP 074
    4 JUMP=0                                                            NTCP 075
      PRPC=CR(KN)                                                       NTCP 076
      CALL STA2                                                         NTCP 077
      CR(KN)=PRPC                                                       NTCP 078
      IF (PREVER) GO TO 40                                              NTCP 079
      IF (1.-MF2(1,KN))24,5,5                                           NTCP 080
    5 IF (JUMP)6,6,20                                                   NTCP 081
    6 CALL STA2A                                                        NTCP 082
      IF (PREVER) GO TO 40                                              NTCP 083
      IF (KN-KSTG)7,9,9                                                 NTCP 084
    7 KN=KN+1                                                           NTCP 085
      LOPIN=0                                                           NTCP 086
    8 JUMP=0                                                            NTCP 087
```

Listing of Code (continued)

```
      PRPC=CS(KN)                                                       NTCP 088
      CALL STA1                                                         NTCP 089
      CS(KN)=PRPC                                                       NTCP 090
      IF (PREVER) GO TO 40                                              NTCP 091
      IF (JUMP)3,3,20                                                   NTCP 092
    9 CALL OVRALL                                                       NTCP 093
      IF (VCTD)11,11,10                                                 NTCP 094
   10 CALL INSTG                                                        NTCP 095
   11 PASS=1.                                                           NTCP 096
      IF (TRDIAG)13,13,12                                               NTCP 097
   12 CALL DIAGT(0)                                                     NTCP 098
   13 IF (1.-MFSTOP)24,24,14                                            NTCP 099
   14 IF (DELC)24,24,15                                                 NTCP 100
   15 IF (DELL)17,17,16                                                 NTCP 101
   16 IF(DELPR)24,24,18                                                 NTCP 102
   17 IF (CHOKE)24,18,24                                                NTCP 103
   18 ISCASE=ISCASE+1                                                   NTCP 104
   19 JL=(ISORH-1)*8+LSTG                                               NTCP 105
      IF(SC.EQ.1.) DELPR=DELL                                           NTCP 106
      PTOPS1(IP,JL)=PTOPS1(IP,JL)+DELPR                                 NTCP 107
   20 LOPIN=1                                                           NTCP 108
      KN=LSTG                                                           NTCP 109
      IBRC=LBRC                                                         NTCP 110
      IPC=0                                                             NTCP 111
      IF (KN-1)21,21,22                                                 NTCP 112
   21 IF (ISORH-1)2,2,4                                                 NTCP 113
   22 IF (ISORH-1)8,8,4                                                 NTCP 114
   40 WRITE(6,106)                                                      NTCP 115
   24 IF (ENDJOB-1.)1,23,23                                             NTCP 116
   23 IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(1H1,40H AN EXIT HAS BEEN MADE FROM MAIN PROGRAM)           ********
      CALL EXIT                                                         ********
  106 FORMAT(//3X65HTHE PREVIOUS CASE HAS BEEN TERMINATED DUE TO ERRORS NTCP 118
     1- CHECK DUMP.)                                                    NTCP 119
      STOP                                                              NTCP 120
      END                                                               NTCP 121
```

Listing of Code (continued)

```
      SUBROUTINE INIT                                                   INIT 001
CINIT                                                                   INIT 002
C     SUBROUTINE FOR INITIALIZATION OF INPUT DATA                       INIT 003
C                                                                       INIT 004
      REAL MFSTOP                                                       INIT 005
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    INIT 007
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   INIT 008
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, INIT 009
     3DELPR,PASS,IPC,LOPC,ISS                                           INIT 010
C                                                                       INIT 011
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)INIT 012
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),INIT 013
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),    INIT 014
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)          INIT 015
C                                                                       INIT 016
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  INIT 018
     2EXPP,EXPRE,   RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARINIT 021
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)INIT 022
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(INIT 023
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)INIT 024
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              INIT 025
C                                                                       INIT 026
      DIMENSION                          H1A(6,8),H0(6,8),H2A(6,8)      INIT 027
C                                                                       INIT 028
C     READ INPUT DATA, CHECK FOR ERRORS,                                INIT 029
C          SKIP CHANGE CASES IF BASIC CASE HAS AN ERROR                 INIT 030
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE INIT   )          ********
    3 CALL INPUT                                                        INIT 031
      ICASE=ICASE+1                                                     INIT 032
      IF(STGCH)5,5,4                                                    INIT 033
    4 IK=1                                                              INIT 034
    5 CALL CHECK(L)                                                     INIT 035
      GO TO(6,8),L                                                      INIT 036
    6 WRITE(6,100)ICASE                                                 INIT 037
      IF(STGCH)3,3,7                                                    INIT 038
    7 IK=2                                                              INIT 039
      GO TO 3                                                           INIT 040
    8 IF (IK-2)9,3,3                                                    INIT 041
C        INITIALIZE INDEX REGISTERS AND FORKS                           INIT 042
    9 ISECT=SECT+.0001                                                  INIT 043
```

Listing of Code (continued)

```
      KSTG= STG+.0001
      LOPC=0
      CHOKE=0.
      ICHOKE=0
      ISOHR=1
      KN=1
      LSTG=1
      IHRC=1
      LHRC=1
      DELPR=DELC
      SC=0.0
      RC=0.0
      PRPC=0.0
      IPC=0
      ISS=0
      PTRN=0.0
C         TEST STAGE LOSS INDICATOR
      IF(SLI)13,13,11
   11 DO 12 I=1,ISECT
      DO 12 J=1,KSTG
      ETARS(I,J)=ETARS(I,1)
      ETAS(I,J)=ETAS(I,1)
      CFS(I,J)=CFS(I,1)
      ETARR(I,J)=ETARR(I,1)
      ETAR(I,J)=ETAR(I,1)
      CFR(I,J)=CFR(I,1)
      TFR(I,J)=TFR(I,1)
   12 CONTINUE
C         TEST FOR EQUAL SECTORS
   13 IF(PCNH(1)-1.)16,14,14
   14 DO 15 I=1,ISECT
   15 PCNH(I)=       1./SECT
C         SET UP SECTOR HEIGHT, PITCH DIAMETER, ANNULUS AREA,
C                PITCHLINE WHEEL SPEED
   16 DO 19 K=1,KSTG
          SH0=DT(1,K)-DR(1,K)
          SH1=DT(2,K)-DR(2,K)
          SH1A=DT(3,K)-DR(3,K)
          SH2=DT(4,K)-DR(4,K)
          SH2A=DT(5,K)-DR(5,K)
      DO 18 I=1,ISECT
      H0(I,K)=.5*PCNH(I)*SH0
      H1(I,K)=.5*PCNH(I)*SH1
      H1A(I,K)=.5*PCNH(I)*SH1A
      H2(I,K)=.5*PCNH(I)*SH2
      H2A(I,K)=.5*PCNH(I)*SH2A
      IF(I-1)20,20,17
```

Listing of Code (continued)

```
   20 DP0(I,K)=DR(1,K)+    H0(I,K)                                      INIT 091
      DP1(I,K)=DR(2,K)+    H1(I,K)                                      INIT 092
      DP1A(I,K)=DR(3,K)+    H1A(I,K)                                    INIT 093
      DP2(I,K)=DR(4,K)+    H2(I,K)                                      INIT 094
      DP2A(I,K)=DR(5,K)+    H2A(I,K)                                    INIT 095
      GO TO 21                                                          INIT 096
   17 DP0(I,K)=          H0(I-1,K)+   H0(I,K)+DP0(I-1,K)                INIT 097
      DP1(I,K)=          H1(I-1,K)+   H1(I,K)+DP1(I-1,K)                INIT 098
      DP1A(I,K)=          H1A(I-1,K)+   H1A(I,K)+DP1A(I-1,K)            INIT 099
      DP2(I,K)=          H2(I-1,K)+   H2(I,K)+DP2(I-1,K)                INIT 100
      DP2A(I,K)=          H2A(I-1,K)+   H2A(I,K) +DP2A(I-1,K)           INIT 101
   21 ANN0(I,K)=.0218166*DP0(I,K)*H0(I,K)                               ********
      ANN1(I,K)=.0218166*DP1(I,K)*H1(I,K)                               ********
      ANN1A(I,K)=DP1A(I,K)*H1A(I,K)*.0218166                            ********
      ANN2(I,K)=.0218166*DP2(I,K)*H2(I,K)                               ********
      ANN2A(I,K)=.0218166*DP2A(I,K)*H2A(I,K)                            ********
      U1A(I,K)= 3.14159*DP1A(I,K)*RPM/720.                              INIT 107
      U2(I,K)= 3.14159*DP2(I,K)*RPM/720.                                INIT 108
   18 CONTINUE                                                          INIT 109
   19 CONTINUE                                                          INIT 110
C         DEFINE PITCHLINE INDEX                                        INIT 111
      IT=ISECT-2*(ISECT/2)                                              INIT 112
      IF(IT)22,22,23                                                    INIT 113
   22 IP=ISECT/2                                                        INIT 114
      GO TO 24                                                          INIT 115
   23 IP=(ISECT+1)/2                                                    INIT 116
C         CALCULATE INLET AND EXIT ANGLES IN RADIANS                    INIT 117
   24 IF (ALPHA1(1,1))25,25,27                                          INIT 118
   25 SDEAF=0.                                                          INIT 119
      DO 26 K=1,KSTG                                                    INIT 120
      DO 26 I=1,ISECT                                                   INIT 121
      CSALF1(I,K)=ANDO(I,K)*CFS(I,K)/(SESTHI(K)*3.14159*DP1(I,K)*       INIT 122
     1SQRT(ETAS(I,K)))                                                  INIT 123
   26 ALF1(I,K)=ATAN2(SQRT(1.-CSALF1(I,K)*CSALF1(I,K)),CSALF1(I,K))     INIT 124
      GO TO 31                                                          INIT 125
   27 DO 28 K=1,KSTG                                                    INIT 126
      DO 28 I=1,ISECT                                                   INIT 127
        ALF1(I,K)=     ALPHA1(I,K)*.01745328                            ********
   28 CSALF1(I,K)=COS(ALF1(I,K))                                        INIT 129
   31 IF (BETA2(1,1))29,29,32                                           INIT 130
   29 RDEAF=0.                                                          INIT 131
      DO 30 K=1,KSTG                                                    INIT 132
      DO 30 I=1,ISECT                                                   INIT 133
      CSBET2(I,K)=ANDOR(I,K)*CFR(I,K)/(RERTHI(K)*3.14159*DP2(I,K)*      INIT 134
     1SQRT(ETAR(I,K)))                                                  INIT 135
   30 BET2(I,K)=ATAN2( SQRT(1.-CSBET2(I,K)*CSBET2(I,K)),CSBET2(I,K))    INIT 136
      GO TO 34                                                          INIT 137
```

Listing of Code (continued)

```
   32 DO 33 K=1,KSTG                                                    INIT 138
      DO 33 I=1,ISECT                                                   INIT 139
        BET2(I,K)=     BETA2(I,K)*.01745328                             ********
   33 CSBET2(I,K)=COS(BET2(I,K))                                        INIT 141
   34 DO 35 K=1,KSTG                                                    INIT 142
      DO 35 I=1,ISECT                                                   INIT 143
      PTP(I,K)=PTIN                                                     INIT 144
      PT0(I,K)=PTIN                                                     INIT 145
      TT0(I,K)=TTIN                                                     INIT 146
      ALPHA0(I,K)=0.0                                                   INIT 147
      PT0PS1(I,K)=PTPS                                                  INIT 148
      RADSD(I,K)=ALPHAS(I,K)*.01745328                                  ********
   35 RADRD(I,K)=BETA1(I,K)*.01745328                                   ********
      IF(RV(1,1))36,36,37                                               ********
   36 CALL R(PTIN,TTIN,FAIR,WAIR,RV(1,1))                               ********
      GAMF=0.0                                                          INIT 153
      GO TO 38                                                          INIT 154
   37 GAMF=1.0                                                          INIT 155
   38 CALL CHECK(J)                                                     INIT 156
      GO TO (39,40),J                                                   INIT 157
   39 GO TO 3                                                           INIT 158
   40 IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE INIT  )          ********
      RETURN                                                            ********
  100 FORMAT(28X,6HCASE  I5,13H HAS AN ERROR)                           INIT 160
      END                                                               INIT 161
```

Listing of Code (continued)

```
      SUBROUTINE INPUT
CINPUT
C***********************************************************************
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRFC,ICASE,PRFVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORB,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPH,PASS,IPC,LOPC,ISS
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),SR(6,8),ST(6,8),SWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),ASO(6,8)
     6,ASMPO(6,8),ACMNO(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      DIMENSION X(6,8,38),Y(6,38)
C
      EQUIVALENCE (X(1,1,1), RV(1,1)),(Y(1,1),  RG(1))
C
      COMMON RG(6),
     1       GAMG(6),DR(6),DT(6),RWG(6),SDIA(6),SDEA(6),SREC(6),SETA(6),
     1SCF(6),SPA(6),RDIA(6),RDEA(6),RREC(6),RETA(6),RCF(6),RTF(6),RPA(6)
     2,STPLC(6),SINR(6),SINMP(6),SINMN(6),SCPS(6),SCPC(6),SCPQ(6),SCNS(6
     3),SCNC(6),SCNQ(6),RTPLC(6),RINR(6),RINMP(6),RINMN(6),RCPS(6),RCPC(
     46),RCPQ(6),RCNS(6),RCNC(6),RCNQ(6)
C
      NAMELIST/DATAIN/ RSL,TSL,PSL,GAMSL,
     1                 PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD
     1,STG,SECT,STAGE,EXPN,EXPP,EXPRE,RPM,PAF,SLI,ENDSTG,ENDJOB,PCNH,RG,
     2GAMG,DR,DT,RWG,SDIA,SDEA,SREC,SETA,SCF,SPA,RDIA,RDEA,RREC,RETA,RCF
     3,RTF,RPA,STPLC,SINR,SINMP,SIMMN,SCPS,SCPC,SCPQ,SCNS,SCNC,SCNQ,RTPL
     4C,RINR,RINMP,RINMN,RCPS,RCPC,RCPQ,RCNS,RCNC,RCNQ,SESTH,RERTH,
     5WTOL,RHOTOL,PRTOL,TRLOOP,TRDIAG,STGCH
C
      DATA BLANKS/66666666/
C
C
C     READ THE HEADING CARDS EVERY TIME ENTRY IS MADE
      IF(SRFLAG) WRITE(6,10000)
```

Listing of Code (continued)

```
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE INPUT )              ********
   10 READ(5,6669)  (NAME(I),I=1,10)                                        INPT 043
   20 READ(5,6669)  (TITLE(I),I=1,10)                                       INPT 044
      J=0                                                                   INPT 045
   30 DO 25 L=1,38                                                          ********
      DO 25 I=1,6                                                           INPT 047
   25 Y(I,L)=BLANKS                                                         INPT 048
      SESTH=BLANKS                                                          INPT 049
      RERTH=BLANKS                                                          INPT 050
      READ(5,DATAIN)                                                        INPT 051
   40 K=STAGE+.0001                                                         INPT 052
   50 ISECT=SECT+.0001                                                      INPT 053
   60 DO 80 L=1,38                                                          ********
   70 DO 80 I=1,6                                                           INPT 055
      IF (Y(I,L).NE.BLANKS)  GO TO 71                                       INPT 056
      Y(I,L)=0.0                                                            INPT 057
      GO TO 80                                                              INPT 058
   71 X(I,K,L)=Y(I,L)                                                       INPT 059
   80 CONTINUE                                                              INPT 060
      IF(SESTH.EQ.BLANKS) GO TO 95                                          INPT 061
   90 SESTHI(K)=SESTH                                                       INPT 062
      GO TO 96                                                              INPT 063
   95 SESTH=0.                                                              INPT 064
   96 IF(RERTH.EQ.BLANKS) GO TO 105                                         INPT 065
  100 RERTHI(K)=RERTH                                                       INPT 066
      GO TO 110                                                             INPT 067
  105 RERTH=0.                                                              INPT 068
  110 IF (K-1)120,120,130                                                   INPT 069
  120 WRITE(6,6670)NAME,TITLE,STGCH,TTIN,PTIN,WAIR,FAIR,PTPS,DELC,DELL,     ********
     1DELA,STG,SECT,EXPN,EXPP,    PAF,SI I,AACS,RPM,VCTD,RSL,TSL,PSL,GAMSL********
     2,ENDSTG,ENDJOB,PCNH                                                   ********
      J=J+1                                                                 INPT 073
  130 WRITE(6,6671) K,RG,GAMG,DR,DT,RWG,SDIA,SDEA,SREC,SETA,SCF,SPA,        ********
     1SESTH,                                                                INPT 075
     1RDIA,RDEA,RREC,RETA,RCF,RPA,RTF,RERTH                                 ********
  140 IF (OMEGAS(1,K))160,160,150                                           INPT 077
  150 WRITE(6,6672)STPLC,SINR,SINMP,SINMN,SCPS,SCPC,SCPQ,SCNS,SCNC,SCNQ,INPT 078
     1RTPLC,RINR,RINMP,RINMN,RCPS,RCPC,RCPQ,RCNS,RCNC,RCNQ                  INPT 079
  160 J=J+1                                                                 INPT 080
  180 AM= J-2*(J/2)                                                         INPT 081
  190 IF(AM)200,210,200                                                     INPT 082
  200 WRITE(6,6673)                                                         INPT 083
  210 IF (ENDSTG-1.)30,170,170                                              INPT 084
  170 IF(SRFLAG) WRITE(6,20000)                                             ********
20000 FORMAT(1H1,45H AN EXIT HAS BEEN MADE FROM SUBROUTINE INPUT )          ********
      RETURN                                                                ********
 6669 FORMAT(10A6)                                                          INPT 086
```

Listing of Code (continued)

```
6670 FORMAT (1H1,24X,24HTURBINE COMPUTER PRCGRAM/6X,10A6/6X,10A6/2X,    INPT 087
    17HSCATAIN/2X,7H STGCH=F10.3/2X7H  TTIN=F10.3,1X,7H  PTIN=F10.3,2X,********
    16H WAIR=F10.3,2X,                                                  ********
    25HFAIR=F10.3/2X,7H  PIPS=F10.3,1X,7H  CELC=F10.3,2X,6H DELL=F10.3,********
    32X,5HDELA=F10.3/2X,7H   STG=F10.3,1X,7H  SECT=F10.3,2X,6H EXPN=F10********
    4,3,2X,5HEXPP=F10.3/2X,                   7H   PAF=F10.3,2X,6H  SLI=********
    5F10.3,3X,5HAACS=F10.3,  2X,5H RPM=F10.3/2X,7H  VCTD=F10.3,4X,4HRSL********
    6=F10.3,4X,4HTSL=F10.3,3X,4HPSL=F10.3/2X,7H GAMSL=F10.3,1X,7HENDSTG********
    7=F10.3,1X,7HENDJOB=F10,3//25X,21HINLET RADIAL PROFILES             ********
    8           /4X,5HPCNH=6(F8.3,2X)/1H1)                              ********
6671 FORMAT(28X,15HSTANDARC OPTION/3X,6HSTAGE=I3,16X,14HAXIAL STATIONS/********
    111X,6HSTA. 04X,6HSTA. 14X,6HSTA.1A4X,6HSTA. 23X,7H STA.2A/         ********
    23X,6H   RG=6(F8.3,2X)/                                             ********
    33X,6H GAMG=6(F8.3,2X)/3X,6H   DR=6(F8.3,2X)/3X,6H   DT=6(F8.3,2X)/INPT 097
    33X,6H  RWG=6(F8.3,2X)//22X,27HSTATOR RADIAL DISTRIBUTIONS/         INPT 098
    413X,4HROOT,15X,5HPITCH,16X,3HTIP/                                  ********
    53X,6H SDIA=6(F8.3,2X)/3X,6H SDEA=6(F8.3,2X)/3X,6H SREC=6(F8.3,2X)/INPT 100
    63X,6H SFTA=6(F8.3,2X)/3X,6H  SCF=6(F8.3,2X)/3X,6H  SPA=6(F8.3,2X)/INPT 101
    73X,6HSESTH=F8.3//22X,26HROTOR RADIAL DISTRIBUTIONS/                ********
    83X,6H RDIA=6(F8.3,2X)/3X,6H RDEA=6(F8.3,2X)/3X,6H RREC=6(F8.3,2X)/INPT 103
    93X,6H RETA=6(F8.3,2X)/3X,6H  RCF=6(F8.3,2X)/3X,6H  RPA=6(F8.3,2X)/********
    13X,6H  RTF=6(F8.3,2X)/3X,6HRERTH=1F8.3/)                           ********
6672 FORMAT(/25X,23HLOSS CCEFFICIENT OPTION/22X,27HSTATOR RADIAL DISTRIINPT 106
    1BUTIONS/                                                           INPT 107
    23X,6HSTPLC=6(F8.3,2X)/3X,6H SINR=6(F8.3,2X)/3X,6HSINMP=6(F8.3,2X)/INPT 108
    33X,6HSINMN=6(F8.3,2X)/3X,6H SCPS=6(F8.3,2X)/3X,6H SCPC=6(F8.3,2X)/INPT 109
    43X,6H SCPQ=6(F8.3,2X)/3X,6H SCNS=6(F8.3,2X)/3X,6H SCNC=6(F8.3,2X)/INPT 110
    53X,6H SCNQ=6(F8.3,2X)/023X,26HROTOR RACIAL DISTRIBUTIONS/          INPT 111
    63X,6HRTPLC=6(F8.3,2X)/3X,6H RINR=6(F8.3,2X)/3X,6HRINMP=6(F8.3,2X)/INPT 112
    73X,6HRINMN=6(F8.3,2X)/3X,6H RCPS=6(F8.3,2X)/3X,6H RCPC=6(F8.3,2X)/INPT 113
    83X,6H RCPQ=6(F8.3,2X)/3X,6H RCNS=6(F8.3,2X)/3X,6H RCNC=6(F8.3,2X)/INPT 114
    93X,6H RCNQ=6(F8.3,2X))                                             INPT 115
6673 FORMAT (1H1)                                                       INPT 116
     END                                                                INPT 117
```

Listing of Code (continued)

```
      SUBROUTINE STA01
CSTA01
C     ESTABLISH FIRST STATOR EXIT FLOW, ADJUST FLOWS FOR COOLING
C        AIR INJECTION BETWEEN STATIONS 0 AND 1, FIND INLET
C        MACH NUMBER AND INCIDENCE ANGLE LOSS AT STATION 0,
C        ADJUST PT, GET NEW FLOW AT STATION 1 FOR FINAL RESULT.
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKF,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      REAL M0
      COMMON /SSTA01/CP0(8),                    PS0(6,8),V0(6,8),TS0(6,
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8),
     2             DPDR1(6,8),SI(6,8),  CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8)
C
      DIMENSION         TA0(8),        TTOTS0(6,8),PTOPS0(6,8),FFA0(6,8
     1),AAS0(6,8)
C
C
      IF(SRFLAG) WRITE(6,10000)
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE STA01 )
      K=KN
      SCRIT=0.0
      I=IP
      ID=-1
```

Listing of Code (continued)

```
      WGT1(K)=0.0
      JW=1
      IF(GAMF)2,2,3
    2 TA1(K)=.95*TT0(IP,K)
      CALL GAMMA(PTIN,TA1(K),FAIR,WAIR,GAM(2,K))
    3 CALL FLOW1(I)
      IF (PREVER) GO TO 26
      WGT1(K)=WGT1(K)+WG1(I,K)
C        TEST FOR TIP SECTOR
      IF(ISECT-1)5,5,4
    4 I=I+ID
      IF(I)6,6,22
   22 L=I-ID
      PS1(I,K)=PS1(    L,K)+FLOAT(ID)*DPDR1(    L,K)*(
     1H1(I,K)+H1(    L,K))/2.
      PTOPS1(I,K)=PT0(I,K)/PS1(I,K)
      IF (PTOPS1(I,K)-1.)27,3,3
   27 PTRN=-1.
      PTOPS1(I,K)= 1.0
      GO TO 3
    6 ID=1
      I=IP+ID
      GO TO 22
C        CALCULATE STA 0 FOR INCIDENCE CORRECTION
    5 IF (JW-1)16,16,18
   16 IF(GAMF)7,7,17
    7 GAM(1,K)=GAM(2,K)
   17 EX=(GAM(1,K)-1.)/GAM(1,K)
      EXI=1./EX
      WGT0(K)=WGT1(K)/RWG(2,K)
      I= IP
      WG0(I,K)=WG1(I,K)/RWG(2,K)
      FFA0(I,K)=WG0(I,K)*SQRT(    TT0(I,K))/(144.*PT0(I,K)*
     1ANN0(I,K))
   19 J=1
    8 CALL PRATIO(FFA0(I,K),GAM(1,K),RV(1,K) ,PTOPS0(I,K),PRTOL)   ********
      PS0(I,K)=PTP(I,K)/PTOPS0(I,K)
      TTOTS0(I,K)=PTOPS0(I,K)**EX
      TS0(I,K)=TT0(I,K)/TTOTS0(I,K)
    9 IF(GAMF) 10,10,12
   10 TA0(K)=.5*(TT0(I,K)+TS0(I,K))
      CALL GAMMA(PTIN,TA0(K),FAIR,WAIR,GAM(1,K))
      EX=(GAM(1,K)-1.)/GAM(1,K)
      EXI=1./EX
      IF(J-1)11,11,12
   11 J=J+1
      GO TO 8
```

Listing of Code (continued)

```
   12 CP0(K)=RV(1,K)*EXI/AJ
      DO 14 I=1,ISECT
      WG0(I,K)=WG1(I,K)/RWG(2,K)
      PT0M0= PT0(I,K)
      FFA0(I,K)=WG0(I,K)*SQRT(   TT0(I,K))/(144.*PT0(I,K)*
     1ANN0(I,K))
      IF(I.EQ.IP) GO TO 28
      PS0(I,K) =  PS0(IP,K)
      PT0PS0(I,K) = PTP(I,K)/ PS0(I,K)
   28 TT0TS0(I,K)=PT0PS0(I,K)**EX
      TS0(I,K)=TT0(I,K)/TT0TS0(I,K)
   13 V0(I,K)=SQRT(2.*G*AJ*CP0(K)*(TT0(I,K)-TS0(I,K)))
      AAS0(I,K)=SQRT(GAM(1,K)*G*RV(1,K)*TS0(I,K))
      M0(I,K)=V0(I,K)/AAS0(I,K)
      SI(I,K)=ALPHA0(I,K)- HADSU(I,K)
      IF(SI(I,K))24,24,20
   24 EXPS=EXPN
      GO TO 21
   20 EXPS=EXPP
   21 PT0PS0(I,K)=(1.+EX*M0(I,K)*ETARS(I,K)*GAM(1,K)*M0(I,K)/2.
     1*(COS(SI(I,K))**EXPS))**EXI
      PT0(I,K)=PS0(I,K)*PT0PS0(I,K)
      WG0(I,K)=WG0(I,K)*PT0(I,K)/PT0M0
      WG1(I,K)=WG1(I,K)*PT0(I,K)/PT0M0
      RHOS0(I,K)=144.*PS0(I,K)/(RV(1,K)*TS0(I,K))
      VU0(I,K)=V0(I,K)*SIN(ALPHA0(I,K))
      VZ0(I,K)=V0(I,K)*COS(ALPHA0(I,K))
   14 CONTINUE
C        END OF INCIDENCE LOSS CORRECTION LOOP
      WGT1(K)=0.
      I=IP
      ID=-1
      JW=2
   15 GO TO 3
   18 CONTINUE
      WGT0(K)=WGT1(K)/RWG(2,K)
      IF(TRLOOP.EQ.0.) GO TO 23
      WRITE(6,1000) WGT0(K),WGT1(K),(WG0(L,K),L=1,ISECT)
      WRITE(6,1001)              (PT0PS0(L,K),L=1,ISECT)
      WRITE(6,1002)                  (WG1(L,K),L=1,ISECT)
      WRITE(6,1003)              (PT0PS1(L,K),L=1,ISECT)
 1000 FORMAT(2X,6H WGT0=F8.3,2X,6H WGT1=F8.3/2X,6H   WG0=6F8.3)
 1001 FORMAT(1X,7HPT0PS0=6F8.5)
 1002 FORMAT(2X,6H   WG1=6F8.3)
 1003 FORMAT(1X,7HPT0PS1=6F8.5)
   23 CALL CHECK          (J)
      GO TO (25,26),J
```

Listing of Code (continued)

```
   25 CALL DIAGT(1)                                                    ST01 137
   26 IF(SRFLAG) WRITE(6,20000)                                        ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE STA01 )         ********
      RETURN                                                           ********
      END                                                              ST01 139
```

Listing of Code (continued)

```
      SUBROUTINE FLOW1(I)                                               FLW1 001
CFLOW1                                                                  FLW1 002
C     ESTABLISH VALUES FOR STATOR EXIT FLOW                             FLW1 003
C                                                                       FLW1 004
      REAL MFSTOP                                                       FLW1 005
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    FLW1 007
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   ********
     2LBRC,IBRC,ICHOKE,ISORH,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, FLW1 009
     3DELPR,PASS,IPC,LOPC,ISS                                           FLW1 010
C                                                                       FLW1 011
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)FLW1 012
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),FLW1 013
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),    FLW1 014
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)          FLW1 015
C                                                                       FLW1 016
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  FLW1 018
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,FNDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARFLW1 021
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)FLW1 022
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(FLW1 023
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)FLW1 024
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              FLW1 025
C                                                                       FLW1 026
      REAL M0                                                           FLW1 027
      COMMON /SSTA01/CP0(8),                     PS0(6,8),V0(6,8),TS0(6,FLW1 028
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8), FLW1 029
     2             DPDR1(6,8),SI(6,8),  CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)FLW1 030
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8) ********
C                                                                       FLW1 032
      DIMENSION PHI1C(8),PTPS1C(8),V1C(6,8),TS1C(6,8),RHOS1C(6,8),WG1C(6FLW1 033
     1,8),CSAL1E(6,8),SFF(6,8)                                          FLW1 034
C                                                                       FLW1 035
C                                                                       FLW1 036
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE FLOW1 )           ********
      K=KN                                                              ********
      EX=(GAM(2,K)-1.)/GAM(2,K)                                         FLW1 037
C        COMPUTE ISENTROPIC STATOR TEMPERATURE RATIO                    FLW1 038
    7 PHI1(I,K)=PTOPS1(I,K)**EX                                         FLW1 039
C        TEST FOR LOSS COEFFICIENT INPUT                                FLW1 040
      IF (OMEGAS(1,1))2,2,1                                             FLW1 041
    1 CALL LOSS1(I,K,EX)                                                FLW1 042
```

Listing of Code (continued)

```
    2 TS1(I,K)=TT0(I,K)*(1.-ETAS(I,K)*(1.-1./PHI1(I,K)))               FLW1 043
      IF(I-IP)6,3,6                                                    FLW1 044
    3 IF(GAMF)4,4,5                                                    FLW1 045
    4 TA1(K)=.5*(TT0(I,K)+TS1(I,K))                                    FLW1 046
      CALL GAMMA(PT0(IP,K),TA1(K),FAIR,WAIR,GAM(2,K))                  FLW1 047
    5 EX=(GAM(2,K)-1.0)/GAM(2,K)                                       FLW1 048
      EXI=1./EX                                                        FLW1 049
C     CRITICAL PRESSURE RATIO                                          FLW1 050
      CALL PHIM(EXI,ETAS(I,K),PHI1C(K),PTPS1C(K))                      FLW1 051
      CP1(K)=RV(2,K)*EXI/AJ                                            ********
C        EXIT VELOCITY                                                 FLW1 053
    6 V1(I,K)=SQRT(2.*G*AJ*CP1(K)*(TT0(I,K)-TS1(I,K)))                 FLW1 054
C        EXIT PRESSURE                                                 FLW1 055
      PS1(I,K)=PT0(I,K)/PT0PS1(I,K)                                    FLW1 056
C        EXIT DENSITY                                                  FLW1 057
      RHOS1(I,K)=144.*PS1(I,K)/(RV(2,K)*TS1(I,K))                      ********
C        TEST CRITICAL PRESSURE RATIO                                  FLW1 059
      IF(PTOPS1(I,K)-PTPS1C(K))15, 8,8                                 FLW1 060
C        GREATER THAN CRITICAL                                         FLW1 061
    8 IF (IP-I) 21,9,21                                                FLW1 062
    9 IF (PRPC)10,10,22                                                FLW1 063
C        PREVIOUS PITCH NONCRITICAL                                    FLW1 064
   10 PRPC=1.                                                          FLW1 065
      PTOPS1(I,K)=PTPS1C(K)*(1.+PRTOL)                                 FLW1 066
      GO TO 7                                                          FLW1 067
   21 IF (PTOPS1(I,K).LE.PTOPS1(IP,K))  GO TO 22                       FLW1 068
      GO TO 12                                                         FLW1 069
   22 IF ((I.EQ.1).OR.(I.EQ.ISECT))  SCRIT=1.                          FLW1 070
      GO TO 11                                                         FLW1 071
C        PITCH OR OUTBOARD SECTOR                                      FLW1 072
   11 CONTINUE                                                         FLW1 073
      V1C(I,K)=SQRT(2.*G*AJ*CP1(K)*TT0(I,K)*ETAS(I,K)*(PHI1C(K)        FLW1 074
     1-1.)/PHI1C(K))                                                   FLW1 075
      TS1C(I,K)=TT0(I,K)*(1.-ETAS(I,K)*(1.-1./PHI1C(K)))               FLW1 076
      RHOS1C(I,K)=144.*PT0(I,K)/(  PTPS1C(K)*TS1C(I,K)*RV(2,K))        ********
      WG1C(I,K)=RHOS1C(I,K)*V1C(I,K)*ANN1(I,K)*CSALF1(I,K)             FLW1 078
      WG1(I,K)=WG1C(I,K)                                               FLW1 079
   13 CSAL1E(I,K)=WG1(I,K)/(RHOS1(I,K)*V1(I,K)*ANN1(I,K))              FLW1 080
C     EFFECTIVE STATOR EXIT ANGLE                                      FLW1 081
   14 ALF1E(I,K)=ATAN2(SQRT(1.-CSAL1E(I,K)*CSAL1E(I,K)),               FLW1 082
     1CSAL1E(I,K))                                                     FLW1 083
      GO TO 16                                                         FLW1 084
   12 IF(   PRPC-1.)15,15,24                                           FLW1 085
   24 WG1(I,K)=SFF(I,K)*PT0(I,K)/SQRT(TT0(I,K))                        FLW1 086
      GO TO 13                                                         FLW1 087
C        PRESSURE RATIO LESS THAN CRITICAL OR SUPERSONIC FLOW DECREASE FLW1 088
   15 WG1(I,K)=RHOS1(I,K)*V1(I,K)*ANN1(I,K)*CSALF1(I,K)                FLW1 089
```

Listing of Code (continued)

```
      CSAL1E(I,K)=CSALF1(I,K)                                           FLW1 090
      ALF1E(I,K)=ALF1(I,K)                                              FLW1 091
      SFF(I,K)=WG1(I,K)*SQRT(TTO(I,K))/PTO(I,K)                         FLW1 092
   16 VU1(I,K)=V1(I,K)*SIN(ALF1E(I,K))                                  FLW1 093
      DPDR1(I,K)=.01388889*RHOS1(I,K)*VU1(I,K)*VU1(I,K)/                ********
     1(G*DP1(I,K))                                                      FLW1 095
      VZ1(I,K)=V1(I,K)*CSAL1E(I,K)                                      FLW1 096
      IF(I.LT.ISECT) GO TO 17                                           FLW1 097
      IF(PRPC.EQ.1.) PRPC=2.                                            FLW1 098
   17 CALL CHECK(J)                                                     FLW1 099
      GO TO (19,20),J                                                   FLW1 100
   19 CALL DIAGT(2)                                                     FLW1 101
   20 IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE FLOW1 )          ********
      RETURN                                                            ********
      END                                                               FLW1 103
```

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Listing of Code (continued)

```
      SUBROUTINE LOSS1(I,K,EX)
CLOSS1
C
C     CALCULATE EFFICIENCY
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,   RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),ASO(6,8)
     6,ASMPO(6,8),ACMNO(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      REAL M0
      COMMON /SSTA01/CP0(8),                         PS0(6,8),V0(6,8),TS0(6,
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8),
     2            DPDR1(6,8),SI(6,8),   CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8)
C
C
      IF(SRFLAG) WRITE(6,10000)
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE LOSS1 )
      EXPN=0.0
      EXPP=0.0
      ETARS(I,K)=1.0
      SI(I,K)=ALPHA0(I,K)- RADSD(I,K)
      IF(SI(I,K))5,1,2
    1 W01=OMEGAS(I,K)
      GO TO 9
    2 AS=A1(I,K)
      AC=A2(I,K)
```

Listing of Code (continued)

```
      AQ=A3(I,K)
      IF(ASMPO(I,K)-SI(I,K))3,4,4
    3 WMWS=SI(I,K)/ASMPO(I,K)
      AR=ASMPO(I,K)/ASO(I,K)
      GO TO 8
    4 WMWS=1.0
      AR=SI(I,K)/ASO(I,K)
      GO TO 8
    5 AS=A4(I,K)
      AC=A5(I,K)
      AQ=A6(I,K)
      IF(SI(I,K)-ACMNO(I,K))6,4,4
    6 WMWS=SI(I,K)/ACMNO(I,K)
      AR=ACMNO(I,K)/ASO(I,K)
    8 W01=(1.+AR*AR*(AS+AR*(AC+AR*AQ)))*WMWS*OMEGAS(I,K)
    9 ETAS(I,K)=(1.-(1./(PTOPS1(I,K)*(1.-W01)+W01))**EX)*PHI1(I,K)/
     1(PHI1(I,K)-1.)
      CALL CHECK(J)
      IF(SRFLAG) WRITE(6,20000)
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE LOSS1 )
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE R(P,T,F,W,RX)                                          R     001
CR                                                                      R     002
C     CALCULATE GAS CONSTANT                                            R     003
      WRITE (6,100)                                                     ********
  100 FORMAT (//120H SUBROUTINE  R  HAS BEEN CALLED UPON ***********************
     1**************************************************************************
     2**,//)                                                            ********
      RX=53.35045+(.658*F+32.433*W)/(1.+F+W)                            R     004
      RETURN                                                            R     005
      END                                                               R     006
```

Listing of Code (continued)

```
      SUBROUTINE GAMMA(P,T,F,W,GAMX)                                    GAMA 001
CGAMMA                                                                  GAMA 002
C                                                                       GAMA 003
C     CALCULATE SPECIFIC HEAT RATIO FOR MIXTURE                         GAMA 004
      WRITE (6,100)                                                     ********
  100 FORMAT (//120H SUBROUTINE GAMMA HAS BEEN CALLED UPON  ********************
     1**************************************************************************
     2**,//)                                                            ********
      CALL CPA(P,T,F,W,CPAX)                                            GAMA 005
      IF(F)2,2,1                                                        GAMA 006
    1 CALL CPF(P,T,F,W,CPFX)                                            GAMA 007
    2 IF(W)4,4,3                                                        GAMA 008
    3 CALL CPW(P,T,F,W,CPWX)                                            GAMA 009
    4 CPGX=(CPAX+F*CPFX+W*CPWX)/(1.+F+W)                                GAMA 010
      CALL R(P,T,F,W,RX)                                                GAMA 011
      GAMX=CPGX/(CPGX-RX/778.161)                                       GAMA 012
      RETURN                                                            GAMA 013
      END                                                               GAMA 014
```

Listing of Code (continued)

```
      SUBROUTINE CPA(P,T,F,W,CPAX)
CCPA
C     CALCULATE SPECIFIC HEAT RATIO FOR AIR
      DIMENSION
     1XT(7),A(7)
      WRITE (6,100)                                                     ********
  100 FORMAT (//120H SUBROUTINE CPA HAS BEEN CALLED UPON    *********************
     1*****************************************************************************
     2**,//)                                                            ********
      IF(T-100.)1,2,2
    1 TX=100.
      GO TO 5
    2 IF(6400.-T)3,4,4
    3 TX=6400.
      GO TO 5
    4 TX=T
    5 XT(1)=TX/1000.
      DO 6 I=2,7
    6 XT(I)=XT(I-1)*XT(1)
      CPAX=2.4264907E-01-2.6657395E-02*XT(1)+4.6617756E-02*XT(2)
     1-1.3546542E-02*XT(3)-8.4500931E-04*XT(4)+1.0303393E-03*
     2XT(5)-1.7159795E-04*XT(6)+9.1627911E-06*XT(7)
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE CPF(P,T,F,*,CPFX)
CCPF
C     CALCULATE SPECIFIC HEAT RATIO FOR FUEL
      DIMENSION
     1XT(7),A(7)
      WRITE (6,100)                                                         ********
  100 FORMAT (//120H SUBROUTINE CPF HAS BEEN CALLED UPON    ********************
     1****************************************************************************
     2**,//)                                                                ********
      IF(T-400.)1,2,2
    1 TX=400.
      GO TO 5
    2 IF(3000.-T)3,4,4
    3 TX=3000.
      GO TO 5
    4 TX=T
    5 XT(1)=TX/1000.
      DO 6 I=2,7
    6 XT(I)=XT(I-1)*XT(1)
      CPFX=1.0625243E-01+9.5291284E-01*XT(1)-7.2605169E-01*XT(2)
     1+2.4481406E-01*XT(3)+5.3332162E-02*XT(4)-6.4699814E-02*XT(5)
     2+1.7495567E-02*XT(6)-1.6029820E-03*XT(7)
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE CPW(P,T,F,W,CPWX)
CCPW
C     CALCULATE SPECIFIC HEAT FOR WATER VAPOR
      DIMENSION
     1XT(7),A(7)
      WRITE (6,100)                                                     ********
  100 FORMAT (//120H SUBROUTINE CPW HAS BEEN CALLED UPON  *********************
     1***************************************************************************
     2**,//)                                                            ********
      IF(T-400.)1,2,2
    1 TX=400.
      GO TO 5
    2 IF(3000.-T)3,4,4
    3 TX=3000.
      GO TO 5
    4 TX=T
    5 XT(1)=TX/1000.
      DO 6 I=2,7
    6 XT(I)=XT(I-1)*XT(1)
      CPWX=4.5728850E-01+9.7007556E-02*XT(1)+1.6536409E-01
     1*XT(2)-4.1138066E-02*XT(3)-2.6979575E-02*XT(4)+2.2619243E-02
     2*XT(5)-6.2706207E-03*XT(6)+6.2246710E-04*XT(7)
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE PRATIO(TFF,GAMX,RX,PTPS,PRTOL)
CPRATIO
C     CALCULATE PRESSURE RATIO
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      IF(SRFLAG) WRITE(6,10000)
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE PRATIO)
      A=GAMX/(GAMX-1.)
      B=2./GAMX
      C=(GAMX+1.)/GAMX
      D=TFF*SQRT(RX/(64.3481*A))
      PCRIT=((GAMX+1.)/2.)**A
      PUP=PCRIT
      PLOW=1.0
      PTRMO=0.0
    1 PTR=(PUP+PLOW)/2.
      DELFM=SQRT(1./(PTR**B)-1./(PTR**C))-D
      IF(DELFM)2,3,3
    2 PLOW=PTR
      GO TO 4
    3 PUP=PTR
    4 PRE=(PTR-PTRMO)/PTR
      IF (ABS(PRE)-PRTOL)6,6,5
    5 PTRMO=PTR
      GO TO 1
    6 IF(PCRIT-PTR)7,8,8
    7 PTPS=PCRIT
      GO TO 9
    8 PTPS=PTR
    9 CONTINUE
      IF(SRFLAG) WRITE(6,20000)
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE PRATIO)
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE CHECK(J)                                               CHCK 001
CCHECK                                                                  CHCK 002
C       SUBROUTINE TO CHECK SENSE LIGHTS                                CHCK 003
C                                                                       CHCK 004
      REAL MFSTOP                                                       CHCK 005
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    CHCK 007
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   CHCK 008
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, CHCK 009
     3DELPR,PASS,IPC,LOPC,ISS                                           CHCK 010
C                                                                       CHCK 011
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE CHECK )           ********
      DO 1 I=1,4                                                        CHCK 012
      CALL SLITET(I,J)                                                  CHCK 013
      GO TO (2,1),J                                                     CHCK 014
    1 CONTINUE                                                          CHCK 015
      J=2                                                               CHCK 016
      IF(SRFLAG) WRITE(6,20000)                                         ********
      RETURN                                                            CHCK 017
    2 J=1                                                               CHCK 018
      PREVER=.TRUE.                                                     CHCK 019
      IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE CHECK )          ********
      RETURN                                                            CHCK 020
      END                                                               CHCK 021
```

Listing of Code (continued)

```
      SUBROUTINE STA1A
CSTA1A
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PREC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,   RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      REAL M0
      COMMON /SSTA01/CP0(8),                       PS0(6,8),V0(6,8),TS0(6,
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8),
     2            CPDR1(6,8),SI(6,8),   CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8)
      REAL MR1A
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6
     2,8),MR1A(6,8),TS1A(6,8)
C        DETERMINE FLOW CONDITIONS RELATIVE TO ROTOR,  FIND INCIDENCE
C          ANGLE RECOVERY ROTOR INLET STATIONS.  OBTAIN GAS PROPERTIES,
C          ABSOLUTE TANGENTIAL COMPONENT VELOCITY ADJUSTED FOR DIAMETER
C          CHANGE TO CONSERVE ANGULAR MOMENTUM,  AXIAL COMPONENT
C          VELOCITY ADJUSTED FOR WEIGHT FLOW, AREA,, AND DENSITY CHANGE
C          FROM STA  1.
C
C
      IF(SRFLAG) WRITE(6,10000)
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE STA1A )
      K=KN
```

Listing of Code (continued)

```
      I=IP                                                              ST1A 043
      ID=-1                                                             ST1A 044
      TS1A(I,K)=TS1(I,K)                                                ********
C        RATIO OF FLOW CHANGE                                           ST1A 046
      WR=RWG(3,K)/RWG(2,K)                                              ST1A 047
C        TOTAL STATION FLOW                                             ST1A 048
      WGT1A(K)=WR*WGT1(K)                                               ST1A 049
C        ADJUST TANGENTIAL VELOCITY                                     ST1A 050
   13 VU1A(I,K)=VU1(I,K)*DP1(I,K)/DP1A(I,K)                             ST1A 051
C        ADJUST FLOW                                                    ST1A 052
      WG1A(I,K)=WR*WG1(I,K)                                             ST1A 053
      RHOSTR=RHOS1(I,K)                                                 ST1A 054
C        ADJUST AXIAL VELOCITY                                          ST1A 055
    1 VZ1A(I,K)=WR*VZ1(I,K)*ANN1(I,K)*RHOS1(I,K)/(ANN1A(I,K)            ST1A 056
     1*RHOSTR)                                                          ST1A 057
      V1A     =SQRT(VU1A(I,K)*VU1A(I,K)+VZ1A(I,K)*VZ1A(I,K))            ST1A 058
      IF(I-IP)2,3,2                                                     ST1A 059
    2 EX=(GAM(3,K)-1.)/GAM(3,K)                                         ST1A 060
      EXI=1./EX                                                         ST1A 061
      GO TO 4                                                           ST1A 062
    3 IF(GAMF)12,12,2                                                   ST1A 063
   12 TA1A    =.5*(TT0(I,K)+TS1A(I,K))                                  ********
      CALL GAMMA(PT0(I,K),TA1A    ,FAIR,WAIR,GAM(3,K))                  ST1A 065
      EX=(GAM(3,K)-1.)/GAM(3,K)                                         ST1A 066
      EXI=1./EX                                                         ST1A 067
    4 CP1A(K)=RV(3,K)*EXI/AJ                                            ********
      DELTS=(V1(I,K)*V1(I,K)-V1A     *V1A     )/(2.*G*AJ*CP1A(K))       ST1A 069
      TS1A(I,K)=TS1(I,K)+DELTS                                          ********
      PS1A(I,K)=PS1(I,K)*(1.+DELTS/TS1(I,K))**EXI                       ST1A 071
      RHOS1A     =144.*PS1A(I,K)/(RV(3,K)*TS1A(I,K))                    ********
C        DENSITY ERROR                                                  ST1A 073
      RHOE=(RHOS1A     -RHOSTR)/RHOS1A                                  ST1A 074
      IF (ABS(RHOE)-RHOTOL)6,6,5                                        ST1A 075
    5 RHOSTR=RHOS1A                                                     ST1A 076
      GO TO 1                                                           ST1A 077
    6 RU1A(I,K)=VU1A(I,K)-U1A(I,K)                                      ST1A 078
      R1A(I,K)=SQRT(RU1A(I,K)*RU1A(I,K)+VZ1A(I,K)*VZ1A(I,K))            ST1A 079
      SBET1A     =RU1A(I,K)/R1A(I,K)                                    ST1A 080
      BET1A(I,K)=ATAN2(SBET1A     ,SQRT(1.-SBET1A     *SBET1A     ))    ST1A 081
      IF(OMEGAR(I,K))8,8,7                                              ST1A 082
    7 ETARR(I,K)=1.                                                     ST1A 083
      EXPRE=0.0                                                         ST1A 084
    8 MR1A(I,K)=R1A(I,K)/SQRT(GAM(3,K)*G*RV(3,K)*TS1A(I,K))             ********
      TRTS1A     =1.+(GAM(3,K)-1.)*MR1A(I,K)*MR1A(I,K)/2.               ST1A 086
      IF(TRTS1A.GT.1.) GO TO 32                                         ST1A 087
      PREVER = .TRUE.                                                   ST1A 088
      GO TO 17                                                          ST1A 089
```

Listing of Code (continued)

```
   32 TTR1A(I,K)=TS1A(I,K)*IRTS1A                                           ********
      RI(I,K)=BET1A(I,K)-RACRD(I,K)                                         ST1A 091
      IF(RI(I,K).GT.1.570796) RI(I,K)=1.570796                              ********
      IF(RI(I,K).LT.-1.570796) RI(I,K)= -1.570796                           ********
      IF(RI(I,K))9,9,10                                                     ST1A 094
    9 EXPH=EXPN                                                             ST1A 095
      GO TO 11                                                              ST1A 096
   10 EXPH=EXPP                                                             ST1A 097
   11 PRPS1A      =(1.+(TRTS1A      -1.)*ETARR(I,K)*(COS(RI(I,K))**         ST1A 098
     1EXPH))**EXI                                                           ST1A 099
      PTR1A(I,K)=PS1A(I,K)*PRPS1A                                           ST1A 100
      IF  (ISECT-I)14,16,14                                                 ST1A 101
   14 I=I+ID                                                                ST1A 102
      IF  (I)15,15,13                                                       ST1A 103
   15 ID=1                                                                  ST1A 104
      I=IP+ID                                                               ST1A 105
      GO TO 13                                                              ST1A 106
   16 CONTINUE                                                              ST1A 107
      CALL CHECK(J)                                                         ST1A 108
      GO TO (17,18),J                                                       ST1A 109
   17 CALL DIAGT(3)                                                         ST1A 110
   18 IF(SRFLAG) WRITE(6,20000)                                             ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE STA1A )              ********
      RETURN                                                                ********
      END                                                                   ST1A 112
```

Listing of Code (continued)

```
      SUBROUTINE STA2                                                   ST2  001
CSTA2                                                                   ST2  002
C     SATISFY CONTINUITY OF FLOW AT ROTOR EXIT                          ST2  003
C                                                                       ST2  004
      REAL MFSTOP                                                       ST2  005
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    ST2  007
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   ********
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, ST2  009
     3DELPR,PASS,IPC,LOPC,ISS                                           ST2  010
C                                                                       ST2  011
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)ST2  012
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),ST2  013
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),    ST2  014
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)          ST2  015
C                                                                       ST2  016
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  ST2  018
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARST2  021
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)ST2  022
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(ST2  023
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)ST2  024
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              ST2  025
C                                                                       ST2  026
      REAL MR1A                                                         ST2  027
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),   CP1A(8), ST2  028
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6ST2  029
     2,8),MR1A(6,8),TS1A(6,8)                                           ********
C                                                                       ST2  031
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),ST2  032
     1            PS2(6,8),PHI2(6,8)                                    ST2  033
C                                                                       ST2  034
      REAL MR2,M2      ,MF2                                             ST2  035
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6ST2  036
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)        ST2  037
C                                                                       ST2  038
      DIMENSION WGT2C(8),FFA2(6,8),IS2(8)                               ST2  039
C                                                                       ST2  040
C                                                                       ST2  041
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE STA2   )          ********
      K=KN                                                              ********
      J=1                                                               ST2  042
```

Listing of Code (continued)

```
      SCRIT=0.0
      PTRMO=1.
      IS2(K)=0
      EXI=GAM(3,K)/(GAM(3,K)-1.)
      WR=RWG(4,K)/RWG(3,K)
      DO 1 I=1,ISECT
      TTR2(I,K)=TTR1A(I,K)+(U2(I,K)**2 - U1A(I,K)**2)/(2.*G*AJ*CP1A(K))
      PTR2(I,K)=PTR1A(I,K)*(TTR2(I,K)/TTR1A(I,K))**EXI
    1 WG2(I,K)=WR*WG1A(I,K)
      WGT2(K)=WR*WGT1A(K)
      I=IP
      ID=-1
      WGT2C(K)=0.
      IF(ICHOKE)26,26,3
   26 IF(LOPIN)27,27,3
   27 IF(GAMF)2,2,16
    2 TA2(K)=.95*TTR2(IP,K)
      CALL GAMMA(PTR2(I,K),TA2(K),FAIR,WAIR,GAM(4,K))
   16 FFA2(I,K)=WG2(I,K)*SQRT(TTR2(I,K))/(144.*PTR2(I,K)*CSBET2(I,K)*
     1ANN2(I,K))
      CALL PRATIO(FFA2(I,K),GAM(4,K),RV(4,K),PTRS2(I,K),PRTOL)
    3 CALL FLOW2(I)
      IF (PHEVER) GO TO 22
      WGT2C(K)=WGT2C(K)+WG2(I,K)
      L=1
      IF (PTRS2(I,K).LE.PTRS2(IP,K))    L=I
      IF(ISECT-I)7,7,4
    4 I=I+ID
      IF(I)5,5,6
    5 ID=1
      I=IP+ID
    6 L=I-ID
      PS2(I,K)=PS2(L,K)+FLOAT(ID)*DPDR2(L,K)*(H2(I,K)+H2(L,K)
     1)/2.
      PTRS2(I,K)=PTR2(I,K)/PS2(I,K)
      IF (PTRS2(I,K)-1.)19,19,3
   19 PTRS2(I,K) = 1.0  + PRTOL
      GO TO 3
    7 IF(IS2(K))8,8,9
    8 EXI=GAM(4,K)/(GAM(4,K)-1.)
      CALL PHIM(EXI,ETAR(L,K),PHIX,PRCRIT)
      PRUP=PTR2(IP,K)*PRCRIT*PS2(L,K)/(PTR2(L,K)*PS2(IP,K))
     1*(1.+PRTOL)
      PRLOW=1.
      GO TO 10
    9 IS2(K)=IS2(K)+1
   10 L = IBRC + 1
```

Listing of Code (continued)

```
      IF(ICHOKE.EQ.L) PTRS2(IP,K) = PRUP
      IF(WGT2(K)-WGT2C(K))12,15,11
   11 PRLOW= PTRS2(IP,K)
      GO TO 13
   12 PRUP= PTRS2(IP,K)
      IS2(K)=1
   13 WE=1.-WGT2(K)/WGT2C(K)
      J=J+1
      IF(J-32)29,18,18
   29 IF(ICHOKE-L) 30,31,30
   31 SCRIT= -WE
      GO TO 15
   30 IF(LOPIN)14,14,15
   14 PRE=(PTRS2(IP,K)-PTRWC)/PTRS2(IP,K)
      IF (ABS(PRE)-PRTOL)17,17,24
   17 CONTINUE
      IF (ABS(WE)-WTOL)15,15,23
   24 PTRWO=PTRS2(IP,K)
      WGT2C(K)=0.0
      I=IP
      ID=-1
      IF (SCRIT)28,28,15
   28 PTRS2(IP,K)=.5*(PRLOW+PRUP)
      IF (PTRS2(IP,K).LE.PRCRIT)   PRPC=0.0
      GO TO 3
   23 SCRIT= 1.
   15 IF(TRLOOP.EQ.0.) GO TO 25
   18 WRITE(6,1000)K,PRUP,PRLOW,WE,PRCRIT,J,WGT2(K),WGT2C(K),(WG2(L,K),
     1 L=1,ISECT)
      WRITE(6,1001)(PTRS2(L,K),L=1,ISECT)
 1000 FORMAT(2X,2HK=I4,    2X,6H PRUP=F8.5,2X,6HPRLOW=F8.5,2X,6H   WE=
     1F8.5,1X,7HPRCRIT=F8.5,2X,2HJ=I4/
     22X,6H WGT2=F8.3,2X,6HWGT2C=F8.3/
     32X,6H   WG2=6F8.3)
 1001 FORMAT(2X,6HPTPS2=6F8.5)
   25 CALL CHECK(J)
      GO TO (20,21),J
   20 CALL DIAGT(4)
      GO TO 22
   21 CALL LOOP
   22 IF(SRFLAG) WRITE(6,20000)
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE STA2   )
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE FLOW2(I)
CFLOW2
C     CALCULATE ROTOR EXIT SECTOR FLOW
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),
     1            PS2(6,8),PHI2(6,8)
C
      REAL MR2,M2      ,MF2
      COMMON /SFLOW2/TS2(6,8),CP2(8),H2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)
C
      DIMENSION P1AS2C(8),PHI2C(8),R2C(6,8),TS2C(6,8),RHOS2C(6,8),WG2C(6
     1,8),CBET2E(6,8),AS2(6,8),RFF(6,8)
C
C
      IF(SRFLAG) WRITE(6,10000)
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE FLOW2 )
      K=KN
      EX=(GAM(4,K)-1.)/GAM(4,K)
C        ISENTROPIC ROTOR RELATIVE TEMPERATURE RATIO
   10 PHI2(I,K)= PTRS2(I,K)**EX
      IF(OMEGAR(I,K))2,2,1
    1 CALL LOSS2(I,K)
```

Listing of Code (continued)

```
C         EXIT TEMPERATURES                                              FLW2 043
    2 TS2(I,K)=TTR2(I,K)*(1.-ETAR(I,K)*(1.-1./PHI2(I,K)))                FLW2 044
      IF(I-IP)6,3,6                                                      FLW2 045
    3 IF(    GAMF)4,4,5                                                  FLW2 046
    4 TA2(K)=.5*(TTR2(I,K)+TS2(I,K))                                     FLW2 047
      CALL GAMMA(PTR2(I,K),TA2(K),FAIR,WAIR,GAM(4,K))                    FLW2 048
    5 EXI=GAM(4,K)/(GAM(4,K)-1.)                                         FLW2 049
      EX=1./EXI                                                          FLW2 050
C         CRITICAL PRESSURE RATIO                                        FLW2 051
      CALL PHIM(EXI,ETAR(I,K),PHI2C(K),P1AS2C(K))                        FLW2 052
C         SPECIFIC HEAT AT CONSTANT PRESSURE                             FLW2 053
    6 CP2(K)= RV(4,K)*EXI/AJ                                             ********
C         RELATIVE EXIT VELOCITY                                         FLW2 055
      R2(I,K)=SQRT(2.*G*AJ*CP2(K)*(TTR2(I,K)-TS2(I,K)))                  FLW2 056
C         EXIT PRESSURE                                                  FLW2 057
      PS2(I,K)= PTR2(I,K)/ PTRS2(I,K)                                    FLW2 058
C         EXIT DENSITY                                                   FLW2 059
      RHOS2(I,K)=144.*PS2(I,K)/(RV(4,K)*TS2(I,K))                        ********
C         TEST CRITICAL PRESSURE RATIO                                   FLW2 061
      IF( PTRS2(I,K)-P1AS2C(K))15, 7,7                                   FLW2 062
    7 IF (IP-I) 22,8,22                                                  FLW2 063
    8 IF (PRPC)9,9,18                                                    FLW2 064
    9        PRPC=1.                                                     FLW2 065
       PTRS2(I,K)=P1AS2C(K)*(1.+PRTOL)                                   FLW2 066
      GO TO 10                                                           FLW2 067
   22 IF (PTRS2(I,K).LE.PTRS2(IP,K))    GO TO 18                         FLW2 068
      GO TO 13                                                           FLW2 069
   18 IF ((I.EQ.1).OR.(I.EQ.ISECT))  SCRIT=1.                            FLW2 070
      GO TO 11                                                           FLW2 071
   11 CONTINUE                                                           FLW2 072
      R2C(I,K)=SQRT(2.*G*AJ*CP2(K)*TTR2(I,K)*ETAR(I,K)*(                 FLW2 073
     1PHI2C(K)-1.)/PHI2C(K))                                             FLW2 074
      TS2C(I,K)=TTR2(I,K)*(1.-ETAR(I,K)*(1.-1./PHI2C(K)))                FLW2 075
      RHOS2C(I,K)=144.*PTR2(I,K)/(RV(4,K)*P1AS2C(K)*TS2C(I,K))           ********
      WG2C(I,K)=RHOS2C(I,K)*R2C(I,K)*ANN2(I,K)*CSBET2(I,K)               FLW2 077
   12 WG2(I,K)=WG2C(I,K)                                                 FLW2 078
      GO TO 14                                                           FLW2 079
   13 IF(    PRPC-1.)15,15,24                                            FLW2 080
   24 WG2(I,K)=RFF(I,K)*PTR2(I,K)/SQRT(TTR2(I,K))                        FLW2 081
      GO TO 14                                                           FLW2 082
C         OVEREXPANSION AFTER SUPERSONIC FLOW DECREASE                   FLW2 083
   14 CBET2E(I,K)=WG2(I,K)/(RHOS2(I,K)*R2(I,K)*ANN2(I,K))                FLW2 084
      BET2E(I,K)=ATAN2(SQRT(1.-CBET2E(I,K)*CBET2E(I,K)),CBET2E(I,K))     FLW2 085
      GO TO 16                                                           FLW2 086
   15 WG2(I,K)=RHOS2(I,K)*R2(I,K)*ANN2(I,K)*CSBET2(I,K)                  FLW2 087
      CBET2E(I,K)=CSBET2(I,K)                                            FLW2 088
      BET2E(I,K)= BET2(I,K)                                              FLW2 089
```

Listing of Code (continued)

```
      RFF(I,K)=WG2(I,K)*SQRT(TTR2(I,K))/PTR2(I,K)                        FLW2 090
   16 RU2(I,K)=R2(I,K)*SIN(BET2E(I,K))                                   FLW2 091
      VU2(I,K)=RU2(I,K)-U2(I,K)                                          FLW2 092
      DPDR2(I,K)=  (RHOS2(I,K)*VU2(I,K)*VU2(I,K)/(G*DP2(I,K)))*.01388889********
      VZ2(I,K)=R2(I,K)*CBET2E(I,K)                                       FLW2 094
      AS2(I,K)=SQRT(GAM(4,K)*G*RV(4,K)*TS2(I,K))                         ********
      V2(I,K)=SQRT(VZ2(I,K)*VZ2(I,K)+VU2(I,K)*VU2(I,K))                  FLW2 096
      M2(I,K)=V2(I,K)/AS2(I,K)                                           FLW2 097
      MR2(I,K)=R2(I,K)/AS2(I,K)                                          FLW2 098
      MF2(I,K)=MR2(I,K)*CBET2E(I,K)                                      FLW2 099
      IF(I.LT.ISECT) GO TO 17                                            FLW2 100
      IF(PRPC.EQ.1.) PRPC=2.                                             FLW2 101
   17 CALL CHECK(J)                                                      FLW2 102
      GO TO (19,21),J                                                    FLW2 103
   19 CALL DIAGT(4)                                                      FLW2 104
   21 IF(SRFLAG) WRITE(6,20000)                                          ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE FLOW2 )           ********
      RETURN                                                             ********
      END                                                                FLW2 106
```

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Listing of Code (continued)

```
      SUBROUTINE LOSS2(I,K)                                             LOS2 001
CLOSS2                                                                  LOS2 002
C     CALCULATE ETA R FROM QUADRATIC POLYNOMONIAL                       LOS2 003
C                                                                       LOS2 004
      REAL MFSTOP                                                       LOS2 005
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    LOS2 007
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,    LOS2 008
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, LOS2 009
     3DELPR,PASS,IPC,LOPC,ISS                                           LOS2 010
C                                                                       LOS2 011
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,   LOS2 013
     2EXPP,EXPRE,   RPM,PAF,SLI,STGCH,FNDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARLOS2 016
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)LOS2 017
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(LOS2 018
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)LOS2 019
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              LOS2 020
C                                                                       LOS2 021
      REAL MR1A                                                         LOS2 022
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),  LOS2 023
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6LOS2 024
     2,8),MR1A(6,8),TS1A(6,8)                                           ********
C                                                                       LOS2 026
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),LOS2 027
     1            PS2(6,8),PHI2(6,8)                                    LOS2 028
C                                                                       LOS2 029
C                                                                       LOS2 030
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE LOSS2 )           ********
      ETARR(I,K)=1.0                                                    LOS2 031
      IF(RI(I,K))4,1,2                                                  LOS2 032
    1 W1A2=OMEGAR(I,K)                                                  LOS2 033
      GO TO 8                                                           LOS2 034
    2 AS=B1(I,K)                                                        LOS2 035
      AC=B2(I,K)                                                        LOS2 036
      AQ=B3(I,K)                                                        LOS2 037
      IF(BSMPIA(I,K)-RI(I,K))3,6,6                                      LOS2 038
    3 WMWR=RI(I,K)/BSMPIA(I,K)                                          LOS2 039
      AR=BSMPIA(I,K)/BSIA(I,K)                                          LOS2 040
      GO TO 7                                                           LOS2 041
    4 AS=B4(I,K)                                                        LOS2 042
      AC=B5(I,K)                                                        LOS2 043
```

Listing of Code (continued)

```
      AQ=H6(I,K)                                                      LOS2 044
      IF(RI(I,K)-HCMNIA(I,K))5,6,6                                    LOS2 045
    5 WMWR=RI(I,K)/HCMNIA(I,K)                                        LOS2 046
      AR=HCMNIA(I,K)/BSIA(I,K)                                        LOS2 047
      GO TO 7                                                         LOS2 048
    6 WMWR=1.0                                                        LOS2 049
      AR=RI(I,K)/BSIA(I,K)                                            LOS2 050
    7 W1A2=OMEGAR(I,K)*(1.+AR*AR*(AS+AR*(AC+AR*AQ)))*WMWR             LOS2 051
    8 EX=(GAM(3,K)-1.)/GAM(3,K)                                       LOS2 052
      ETAR(I,K)=(1.-(1./(PTRS2(I,K)*(1.-W1A2)+W1A2))**EX)*PHI2(I,K)/  LOS2 053
     1(PHI2(I,K)-1.)                                                  LOS2 054
      CALL CHECK(J)                                                   LOS2 055
      IF(SRFLAG) WRITE(6,20000)                                       ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE LOSS2 )        ********
      RETURN                                                          LOS2 056
      END                                                             LOS2 057
```

Listing of Code (continued)

```
      SUBROUTINE LOOP                                                   LOOP 001
CLOCP                                                                   LOOP 002
C        HANDLES ALL LOGIC FOR ITERATING TO OBTAIN EXACT CHOKE POINT-   LOOP 003
C                  UNDERFLOW, NO CHOKE INITIAL CHOKE, CHOKE ITERATION   LOOP 004
C                  SUBCRITICAL, CHOKE ITERATION SUPERCRITICAL,MULTIPLE  LOOP 005
C                  CHOKE, CHOKE ITERATION COMPLETE                      LOOP 006
C                                                                       LOOP 007
      REAL MFSTOP                                                       LOOP 008
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    LOOP 010
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   LOOP 011
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, LOOP 012
     3DELPR,PASS,IPC,LOPC,ISS                                           LOOP 013
C                                                                       LOOP 014
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,BLLD,STG,SECT,EXPN,  LOOP 016
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARLOOP 019
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)LOOP 020
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(LOOP 021
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)LOOP 022
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              LOOP 023
C                                                                       LOOP 024
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE LOOP    )         ********
      IJ=8*KSTG                                                         LOOP 025
C     INCREASE BLADE ROW COUNTER                                        LOOP 026
      IBRC=IBRC+1                                                       LOOP 027
C     TEST NEGATIVE SECTOR PRESSURE RATIO                               LOOP 028
      IF (PTRN)18,1,1                                                   LOOP 029
C     TEST CHOKE ITERATION ON BLADE ROW                                 LOOP 030
    1 IF (ICHOKE-IBRC)3,2,3                                             LOOP 031
C     TEST INCREMENT TOLERANCE                                          LOOP 032
    2 IF (PRTOL-DELPR)3,3,4                                             LOOP 033
C     TEST STATION FLOW CRITICAL                                        LOOP 034
    3 IF (SCRIT)5,5,6                                                   LOOP 035
C     CHOKE ITERATION COMPLETE                                          LOOP 036
    4 ICHOKE=0                                                          LOOP 037
      IPC=IBRC                                                          LOOP 038
      ISS=IBRC                                                          LOOP 039
      ISORR=2+(IBRC/2)*2-IBRC                                           LOOP 040
      JL=(ISORR-1)*8+KN                                                 LOOP 041
      IF (JL-IJ)22,23,23                                                LOOP 042
   22 DELPR=DELL                                                        LOOP 043
```

Listing of Code (continued)

```
   24 LOPC=0
      CHOKE=1.
      LSTG=KN
      LBRC=IBRC-1
      GO TO 18
   23 DELPR=DELA
      GO TO 24
    5 IF (ICHOKE-IBRC)18,7,18
C     TEST CHOKE ITERATION LOOP
    6 IF(ISS-IBRC)8,18,18
C     CHOKE ITERATION
C     ISORR = 1 FOR STATOR
C           = 2 FOR ROTOR
    7 DELPR=DELPR/2.
      JL=(ISORR-1)*8+LSTG
      PTOPS1(IP,JL)=PTOPS1(IP,JL)+DELPR
       GO TO 16
C     CHOKE HAS OCURRED
    8 IF(ICHOKE)80,80,13
   80 J=(IBRC-2*(KN-1)-1)*8+KN
      WRITE(6,801)IBRC,PTOPS1(IP,J)
  801 FORMAT(16X10HBLADE ROW I3,8H CHOKED,4X5HPTPS=F10.5)
C     TEST SINGLE CALCULATION POINT
    9 IF (DELC)18,18,10
C     TEST PREVIOUS CHOKE
   10 IF (IPC)11,11,12
C     SAVE COMBINATIONS PRIOR FIRST CHOKE
   11 LBRCS=LBRC
      ISORRS=ISORR
      JL=(ISORR-1)*8+LSTG
      SPTPS=PTOPS1(IP,JL)-DELPR
      LSTGS=LSTG
      SDELPR=DELPR
      GO TO 13
   12 JL=LSTGS+(ISORRS-1)*8
      DELNU = (PTOPS1(IP,JL)-SPTPS)/4.
      IF (DELNU.LE.0.0001) DELNU = SDELPR/4.
      DELPR = DELNU
      SDELPR = DELNU
      WRITE(6,1201)IPC,IBRC,DELPR
 1201 FORMAT(6X11HBLADE ROWS I5,5H AND I5,25H, CHOKED - INCREMENT NOW
     1F10.5)
      LBRC=LBRCS
      LSTG=LSTGS
      ISORR=ISORRS
      PTOPS1(IP,JL) = SPTPS + SDELPR
      LOPC=10
```

Listing of Code (continued)

```
      ICHOKE=0
      IPC=0
      ISS=0
      CHOKE=0.0
      GO TO 17
C     TEST PREVIOUS COMPLETE CALCULATION
   13 IF (PASS)15,15,14
   14 ICHOKE=IBRC
      DELPR=.5*DELPR
   15 JL=(ISORR-1)*8+LSTG
      PTOPS1(IP,JL)=PTOPS1(IP,JL)-DELPR
C     SET INDEX REGISTERS
   16 CONTINUE
      LOPC=LOPC+1
C SET JUMP FOR CHOKE ITERATION
   17 JUMP=1
      GO TO 19
C     JUMP SET FOR NO CHOKE OR CHOKE COMPLETE
   18 JUMP=0
C     TEST LOOP-TRACE
   19 IF (TRLOOP)21,21,20
   20 WRITE(6,2001)IBRC,LBRC,ISORR,KN,LSTG,IPC,ISS,ICHOKE,JUMP,LBRCS,
     1ISORRS,LSTGS,SPTPS,PTOPS1(IP,JL),DELPR,DELL,SCRIT,LOPC
 2001 FORMAT(3X12I5/3X4F10.5,F10.0,I10)
   21 IF(SRFLAG) WRITE(6,20000)
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE LOOP   )
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE STA2A                                                  ST2A 001
CSTA2A                                                                  ST2A 002
C     DETERMINE INLET FLOW CONDITIONS TO ALL STATORS                    ST2A 003
C                       AFTER THE FIRST STATOR                          ST2A 004
C                                                                       ST2A 005
      REAL MFSTOP                                                       ST2A 006
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    ST2A 008
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   ********
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, ST2A 010
     3DELPR,PASS,IPC,LOPC,ISS                                           ST2A 011
C                                                                       ST2A 012
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)ST2A 013
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),ST2A 014
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),    ST2A 015
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)          ST2A 016
C                                                                       ST2A 017
C                                                                       ST2A 018
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  ST2A 020
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,FNDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),FTAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARST2A 023
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)ST2A 024
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(ST2A 025
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)ST2A 026
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              ST2A 027
C                                                                       ST2A 028
      REAL M0                                                           ST2A 029
      COMMON /SSTA01/CP0(8),                    PS0(6,8),V0(6,8),TS0(6,ST2A 030
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8), ST2A 031
     2            DPDR1(6,8),SI(6,8),  CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)ST2A 032
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8) ********
C                                                                       ST2A 034
      REAL MR1A                                                         ST2A 035
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),  ST2A 036
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6ST2A 037
     2,8),MR1A(6,8),TS1A(6,8)                                           ********
C                                                                       ST2A 039
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),ST2A 040
     1           PS2(6,8),PHI2(6,8)                                     ST2A 041
C                                                                       ST2A 042
      REAL MR2,M2     ,MF2                                              ST2A 043
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6ST2A 044
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)        ST2A 045
```

Listing of Code (continued)

```
                                                                        ST2A 046
      REAL M2A,MF2A                                                     ST2A 047
      COMMON /SSTA2A/WG2A(6,8),WGT2A(8),VU2A(6,8),VZ2A(6,8),PS2A(6,8),  ST2A 048
     1ALF2A(6,8),TT2A(6,8),FT2A(6,8),TTBAR(8),PTBAR(8),STT0(8),SPT0(8), ST2A 049
     2M2A(6,8),MF2A(6,8),CP2A(8),V2A(6,8),TS2A(6,8),TAS(8),PAS(8),GAMS(8ST2A 050
     3),CPS(8),DELHVD(6,8),HVBAR(8)                                     ********
C                                                                       ST2A 052
      DIMENSION             TTTS2A(6,8)                                 ST2A 053
C                                                                       ST2A 054
C                                                                       ST2A 055
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE STA2A )           ********
      K=KN                                                              ********
      ID=-1                                                             ST2A 056
      I=IP                                                              ST2A 057
      TS2A(I,K)=TS2(I,K)                                                ST2A 058
      WR=RWG(5,K)/RWG(4,K)                                              ST2A 059
      SUMT=0.0                                                          ST2A 060
      SUMLT=0.0                                                         ST2A 061
      SUMLP=0.0                                                         ST2A 062
      WGT2A(K)=WR*WGT2(K)                                               ST2A 063
   12 VU2A(I,K)=VU2(I,K)*DP2(I,K)/DP2A(I,K)                             ST2A 064
      WG2A(I,K)=WR*WG2(I,K)                                             ST2A 065
      RHOSTR=RHOS2(I,K)                                                 ST2A 066
    1 VZ2A(I,K)=WR*VZ2(I,K)*ANN2(I,K)*RHOS2(I,K)/(ANN2A(I,K)*RHOSTR)    ST2A 067
      V2A(I,K)=SQRT(VU2A(I,K)*VU2A(I,K)+VZ2A(I,K)*VZ2A(I,K))            ST2A 068
      IF(I-IP)4,2,4                                                     ST2A 069
    2 IF(    GAMF)3,3,4                                                 ST2A 070
    3 TA2A    =.5*(TTR2(I,K)+TS2A(I,K))                                 ST2A 071
      CALL GAMMA(PTR2(IP,K),TA2A    ,FAIR,WAIR,GAM(5,K))                ST2A 072
    4 EX=(GAM(5,K)-1.)/GAM(5,K)                                         ST2A 073
      EXI=1./EX                                                         ST2A 074
      CP2A(K)=RV(5,K)*EXI/AJ                                            ********
      DELTS=(V2(I,K)*V2(I,K)-V2A(I,K)*V2A(I,K))/(2.*G*AJ*CP2A(K))       ST2A 076
      TS2A(I,K)=TS2(I,K)+DELTS                                          ST2A 077
      IF(TS2A(I,K).GT.0.) GO TO 32                                      ST2A 078
      PREVER = .TRUE.                                                   ST2A 079
      MFSTOP = 2.                                                       ST2A 080
      GO TO 30                                                          ST2A 081
   32 PS2A(I,K)=PS2(I,K)*(1.+DELTS/TS2(I,K))**EXI                       ST2A 082
      RHOS2A     =144.*PS2A(I,K)/(RV(5,K)*TS2A(I,K))                    ********
      IF(ABS(RHOSTR-RHOS2A     )-1.E-07)6,6,5                           ST2A 084
    5 RHOSTR=RHOS2A                                                     ST2A 085
      GO TO 1                                                           ST2A 086
    6 SALF2A     =VU2A(I,K)/V2A(I,K)                                    ST2A 087
      ALF2A(I,K)=ATAN2(SALF2A     ,SQRT(1.-SALF2A     *SALF2A     ))    ST2A 088
   11 IF (I-IP)28,24,28                                                 ST2A 089
```

Listing of Code (continued)

```
24 IF (GAMF)25,25,26                                          ST2A 090
25 TAS(K)=.5*(TA1(K)+TA2(K))                                  ST2A 091
   PAS(K)=.5*(PT0(IP,K)+PT2A(IP,K))                           ST2A 092
   CALL GAMMA(PAS(K),TAS(K),FAIR,WATR,GAMS(K))                ST2A 093
   GO TO 27                                                   ST2A 094
26 GAMS(K)=.5*(GAM(2,K)+GAM(4,K))                             ST2A 095
27 E4=GAMS(K)/(GAMS(K)-1.)                                    ST2A 096
   RVBAR(K)=.5*(RV(2,K)+RV(4,K))                              ********
   CPS(K)=RVBAR(K)*E4/AJ                                      ********
28 DELHVD(I,K)=(U1A(I,K)*VU1A(I,K)+U2(I,K)*VU2(I,K))/AJ/G     ST2A 098
   M2A(I,K)=V2A(I,K)/SQRT(GAM(5,K)*G*RV(5,K)*TS2A(I,K))       ********
   DELTT=TFR(I,K)*DELHVD(I,K)/CPS(K)                          ST2A 100
   TT2A(I,K)=TT0(I,K)-DELTT                                   ST2A 101
   TTTS2A(I,K)=1.+(M2A(I,K)*M2A(I,K)*(GAM(5,K)-1.)/2.)        ST2A 102
   PTPS2A     = (TTTS2A(I,K))**EXI                            ST2A 103
   PT2A(I,K)=PS2A(I,K)*PTPS2A                                 ST2A 104
   MF2A(I,K)=M2A(I,K)*COS(ALF2A(I,K))                         ST2A 105
   IF (ISECT-I)13,15,13                                       ST2A 106
13 I=I+ID                                                     ST2A 107
   IF (I)14,14,12                                             ST2A 108
14 ID=1                                                       ST2A 109
   I=IP+ID                                                    ST2A 110
   GO TO 12                                                   ST2A 111
15 CONTINUE                                                   ST2A 112
   DO 16 I=1,ISECT                                            ST2A 113
   RW=WG2A(I,K)/WGT2A(K)                                      ST2A 114
   TR=TT2A(I,K)/TT2A(IP,K)                                    ST2A 115
   PR=PT2A(I,K)/PT2A(IP,K)                                    ST2A 116
   SUMT=SUMT+RW*TR                                            ST2A 117
   SUMLT=SUMLT+RW*ALOG(TR)                                    ST2A 118
16 SUMLP=SUMLP+RW*ALOG(PR)                                    ST2A 119
   E3=GAM(5,K)/(GAM(5,K)-1.)                                  ST2A 120
   TTBAR(K)=TT2A(IP,K)*SUMT                                   ST2A 121
   PTBAR(K)=PT2A(IP,K)*EXP(SUMLP+E3*(ALOG(SUMT)-SUMLT))       ST2A 122
   IF (K-KSTG)17,18,18                                        ST2A 123
17 STT0(K+1)=TTBAR(K)                                         ST2A 124
   SPT0(K+1)=PTBAR(K)                                         ST2A 125
   DO 23 I=1,ISECT                                            ST2A 126
29 SI(I,K+1)=ALF2A(I,K)- RADSD(I,K+1)                         ST2A 127
   IF(SI(I,K+1).GT. 1.570796) SI(I,K+1)= 1.570796             ********
   IF(SI(I,K+1).LT.-1.570796) SI(I,K+1)=-1.570796             ********
   IF(OMEGAS(I,K))8,8,7                                       ST2A 130
 7 ETARS(I,K+1)=1.0                                           ST2A 131
   EXPSI=0.                                                   ST2A 132
   GO TO 117                                                  ST2A 133
 8 IF(SI(I,K+1))9,9,10                                        ST2A 134
 9 EXPSI=EXPN                                                 ST2A 135
```

Listing of Code (continued)

```
      GO TO 117
   10 EXPSI=EXPP
  117 IF (PAF-1.)19,20,21
C     UNIFORM PROFILES
   19 PTP(I,K+1)=PTBAR(K)
      PTO(I,K+1)= PTP(I,K+1)
     1*(1.+(TTTS2A(I,K)-1.)*ETARS(I,K+1)*(COS(SI(I,K+1))**EXPSI))**EXI
     2/(TTTS2A(I,K))**EXI
      TTO(I,K+1)=TTBAR(K)
      GO TO 23
C     SAVE PROFILES
   20 PTP(I,K+1)=PT2A(I,K)
      PTO(I,K+1)= PTP(I,K+1)
     1*(1.+(TTTS2A(I,K)-1.)*ETARS(I,K+1)*(COS(SI(I,K+1))**EXPSI))**EXI
     2/(TTTS2A(I,K))**EXI
      GO TO 22
C     SMOOTH PRESSURE PROFILES
   21 PTP(I,K+1)=PTBAR(K)*(TT2A(I,K)/TTBAR(K))**E3
      PTO(I,K+1)= PTP(I,K+1)
     1*(1.+(TTTS2A(I,K)-1.)*ETARS(I,K+1)*(COS(SI(I,K+1))**EXPSI))**EXI
     2/(TTTS2A(I,K))**EXI
   22 TTO(I,K+1)=TT2A(I,K)
   23 CONTINUE
   18 MFSTOP=MF2A(IP,K)/AACS
      CALL CHECK(J)
      GO TO (30,31),J
   30 CALL DIAGT(5)
   31 IF(SRFLAG) WRITE(6,20000)
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE STA2A )
      RETURN
      END
```

Listing of Code (continued)

```
      SUBROUTINE STA1
CSTA1
C     SATISFY CONTINUITY OF FLOW AT EXIT OF ALL STATORS
C                             AFTER THE FIRST STATOR
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      REAL M0
      COMMON /SSTA01/CP0(8),                       PS0(6,8),V0(6,8),TS0(6,
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8),
     2           DPDR1(6,8),SI(6,8),   CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8)
C
      REAL M2A,MF2A
      COMMON /SSTA2A/WG2A(6,8),WGT2A(8),VU2A(6,8),VZ2A(6,8),PS2A(6,8),
     1ALF2A(6,8),TT2A(6,8),PT2A(6,8),TTBAR(8),PTBAR(8),STT0(8),SPT0(8),
     2M2A(6,8),MF2A(6,8),CP2A(8),V2A(6,8),TS2A(6,8),TAS(8),PAS(8),GAMS(8
     3),CPS(8),DELHVD(6,8),HVBAR(8)
C
      DIMENSION WGT1C(8),LC1(8),FFA1(6,8)
C
C
      IF(SRFLAG) WRITE(6,10000)
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE STA1   )
      K=KN
```

Listing of Code (continued)

```
      J=1                                                               ST1  043
      SCRIT=0.0                                                         ST1  044
      PTRMO=1.                                                          ST1  045
      WR1=RWG(1,K)/RWG(5,K-1)                                           ********
      WR=RWG(2,K)/RWG(5,K-1)                                            ST1  046
      DO 1 I=1,ISECT                                                    ST1  047
      WG0(I,K)=WR1*WG2A(I,K-1)                                          ********
      WG1(I,K)=WR*WG2A(I,K-1)                                           ST1  048
      ALPHA0(I,K)   =ALF2A(I,K-1)                                       ST1  049
        PS0(I,K)  =    PS2A(I,K-1)                                      ST1  050
         V0(I,K)  =     V2A(I,K-1)                                      ST1  051
        TS0(I,K)  =    TS2A(I,K-1)                                      ST1  052
        VU0(I,K)  =    VU2A(I,K-1)                                      ST1  053
        VZ0(I,K)  =    VZ2A(I,K-1)                                      ST1  054
         M0(I,K)  =     M2A(I,K-1)                                      ST1  055
    1 CONTINUE                                                          ********
      CP0(K)=CP2A(K-1)                                                  ********
      WGT0(K)=WR1*WGT2A(K-1)                                            ********
      WGT1(K)=WR*WGT2A(K-1)                                             ********
      I=IP                                                              ST1  057
      ID=-1                                                             ST1  058
      WGT1C(K)=0.0                                                      ST1  059
      LC1(K)=0                                                          ST1  060
      IF(ICHOKE)17,17,16                                                ST1  061
   17 IF(LOPIN)18,18,16                                                 ST1  062
   18 IF(GAMF)2,2,3                                                     ST1  063
    2 TA1(K)=.95*TTO(IP,K)                                              ST1  064
      CALL GAMMA(PTO(IP,K),TA1(K),FAIR,WAIR,GAM(2,K))                   ST1  065
    3 FFA1(I,K)=WG1(I,K)*SQRT(TTO(I,K))/(144.*PTO(I,K)*ANN1(I,K)        ST1  066
     1*CSALF1(I,K))                                                     ST1  067
      CALL PRATIO(FFA1(I,K),GAM(2,K),RV(2,K),PTOPS1(I,K),PRTOL)         ********
   16 CALL FLOW1(I)                                                     ST1  069
      IF (PRFVER) GO TO 25                                              ST1  070
      WGT1C(K)=WGT1C(K)+WG1(I,K)                                        ST1  071
      L=1                                                               ST1  072
      IF (PTOPS1(I,K).LE.PTOPS1(IP,K)) L=I                              ST1  073
      IF(ISECT-I)7,7,4                                                  ST1  074
    4 I=I+ID                                                            ST1  075
      IF(I)5,5,6                                                        ST1  076
    5 ID=1                                                              ST1  077
      I=IP+ID                                                           ST1  078
    6 L=I-ID                                                            ST1  079
      PS1(I,K)=PS1(L,K)+FLOAT(ID)*DPDR1(L,K)*(H1(I,K)+H1(L,K))/2.       ST1  080
      PTOPS1(I,K)=PTO(I,K)/PS1(I,K)                                     ST1  081
      GO TO 16                                                          ST1  082
    7 IF(LC1(K))8,8,9                                                   ST1  083
    8 LC1(K)=1                                                          ST1  084
```

Listing of Code (continued)

```
      EX=GAM(2,K)/(GAM(2,K)-1.)
      CALL PHIM(EX,ETAS(L,K),PHIX,PRCRIT)
      PRUP= PTOPS1(IP,K)*PRCRIT/PTOPS1(L,K)
     1*(1.+PRTOL)
      PRLOW=1.0
      GO TO 10
    9 LC1(K)=LC1(K)+1
   10 L = IBRC + 1
      IF(ICHOKE.EQ.L) PTOPS1(IP,K) = PRUP
      IF(WGT1(K)-WGT1C(K))12,15,11
   11 PRLOW=PTOPS1(IP,K)
      GO TO 13
   12 PRUP=PTOPS1(IP,K)
   13 WE=1.-WGT1(K)/WGT1C(K)
      J=J+1
      IF(J-32)29,22,22
   29 IF(ICHOKE-L) 30,31,30
   31 SCRIT= -WE
      GO TO 15
   30 IF(LOPIN)14,14,15
   14 PRE=(PTOPS1(IP,K)-PTRMO)/PTOPS1(IP,K)
      IF (ABS(PRE)-PRTOL)21,21,27
   21 CONTINUE
      IF (ABS(WE)-WTOL)15,15,20
   27 PTRMO=PTOPS1(IP,K)
      WGT1C(K)=0.0
      I=IP
      ID=-1
      IF (SCRIT)19,19,15
   19 PTOPS1(IP,K)=.5*(PRLOW+PRUP)
      IF (PTOPS1(IP,K).LE.PRCRIT)   PRPC=0.
      GO TO 16
   20 SCRIT= 1.
   15 IF(TRLOOP.EQ.0.) GO TO 28
   22 WRITE(6,1000)K,PRUP,PRLOW,WE,PRCRIT,J,WGT1(K),WGT1C(K),(WG1(L,K),
     1 L=1,ISECT)
      WRITE(6,1001)(PTOPS1(L,K),L=1,ISECT)
 1000 FORMAT(2X,2HK=I4,    2X,6H PRUP=F8.5,2X,6HPRLOW=F8.5,2X,6H    WE=
     1F8.5,1X,7HPRCRIT=F8.5,2X,2HJ=I4/
     22X,6H WGT1=F8.3,2X,6HWGT1C=F8.3/
     32X,6H  WG1=6F8.3)
 1001 FORMAT(1X,7HPTOPS1=6F8.5)
   28 CALL CHECK(J)
      GO TO (23,24),J
   23 CALL DIAGT(2)
      GO TO 25
   24 CALL LOOP
```

Listing of Code (continued)

```
   25 IF(SRFLAG) WRITE(6,20000)                                                  ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE STA1   )                  ********
      RETURN                                                                     ********
      END                                                                        ST1  133
```

Listing of Code (continued)

```
      SUBROUTINE OVRALL
COVRALL
C     PURPOSE IS TO CALCULATE STAGE PERFORMANCE VALUES
C     AFTER FLOW ITERATION IS COMPLETED THROUGH THE LAST STAGE
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,   RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      REAL M0
      COMMON /SSTA01/CP0(8),                     PS0(6,8),V0(6,8),TS0(6,
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8),
     2           DPDR1(6,8),SI(6,8),  CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8)
C
      REAL MR1A
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6
     2,8),MR1A(6,8),TS1A(6,8)
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),
     1          PS2(6,8),PHI2(6,8)
C
      REAL MR2,M2     ,MF2
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)
C
      REAL M2A,MF2A
```

Listing of Code (continued)

```
      COMMON /SSTA2A/WG2A(6,8),WGT2A(8),VU2A(6,8),VZ2A(6,8),PS2A(6,8),  OVLL 046
     1ALF2A(6,8),TT2A(6,8),PT2A(6,8),TTBAR(8),PTBAR(8),STT0(8),SPT0(8), OVLL 047
     2M2A(6,8),MF2A(6,8),CP2A(8),V2A(6,8),TS2A(6,8),TAS(8),PAS(8),GAMS(8OVLL 048
     3),CPS(8),DELHVD(6,8),HVBAR(8)                                     ********
C                                                                       OVLL 050
      COMMON /SOVRAL/DELHT(6,8),DELHTI(6,8),DELHSI(6,8),DEHATI(6,8),    OVLL 051
     1ETATT(6,8),ETATS(6,8),ETATAT(6,8)                                 OVLL 052
C                                                                       OVLL 053
      REAL MIS(8),MIRS(8),MM1AR(8),MR2T(8)                              OVLL 054
      DIMENSION SA0(8),SIS(8),SB1A(8),SIR(8),SA2(8),THCR(8),EPSI(8),DELTOVLL 055
     1(8),SETATT(8),SETATS(8),SETAAT(8),SWRTP(8),SNRT(8),SDHT(8),SETHC(8OVLL 056
     2),SNRTHC(8),SWRTED(8),SPTPT2(8),SPTPS2(8),ST2TT0(8),STRTT0(8),UPS(OVLL 057
     38),UPUPS(8),URS(8),URURS(8),VIS(8),UPVIS(8),URVIS(8),PSIPS(8),PSIROVLL 058
     4S(8),RXP(8),RXR(8),DBETAR(8),DELHTS(8),DEHTIS(8),DEHSIS(8),DHATIS(OVLL 059
     58),PAT2A(6,8)                                                     ********
C                                                                       OVLL 061
C ************** CARD DELETED ******************                        ********
C                                                                       OVLL 063
C                                                                       OVLL 064
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE OVRALL)           ********
      STT0(1)=TTIN                                                      OVLL 065
      SPT0(1)=PTIN                                                      OVLL 066
      RGO=0.0                                                           ********
      TAO=0.0                                                           OVLL 067
      PAO=0.0                                                           OVLL 068
      GAMO=0.0                                                          OVLL 069
      OUPUP=0.0                                                         OVLL 070
      OURUR=0.0                                                         OVLL 071
      ODELHT=0.0                                                        OVLL 072
    5 E1=GAMSL/(GAMSL-1.)                                               OVLL 073
      DO 17 K=1,KSTG                                                    OVLL 074
      RGO=RGO+RVBAR(K)                                                  ********
      IF (GAMF)1,1,2                                                    OVLL 075
    1 TAO=TAO+TAS(K)                                                    OVLL 076
      PAO=PAO+PAS(K)                                                    OVLL 077
      GO TO 3                                                           OVLL 078
    2 GAMO=GAMO+GAMS(K)                                                 OVLL 079
    3 E2=GAM(1,K)/(GAM(1,K)-1.)                                         OVLL 080
      E3=GAM(5,K)/(GAM(5,K)-1.)                                         OVLL 081
      E4=GAMS(K)/(GAMS(K)-1.)                                           OVLL 082
      E5=1./E4                                                          OVLL 083
      DELHTS(K)=0.0                                                     OVLL 084
      DEHTIS(K)=0.0                                                     OVLL 085
      DEHSIS(K)=0.0                                                     OVLL 086
      DHATIS(K)=0.0                                                     OVLL 087
      DO 6 I=1,ISECT                                                    OVLL 088
```

Listing of Code (continued)

```
      RW=WG2A(I,K)/WGT2A(K)                                               OVLL 089
      DELHT(I,K)=DELHVD(I,K)*TFR(I,K)                                     OVLL 090
      DELHTI(I,K)=CPS(K)*TTO(I,K)*(1.-(PT2A(I,K)/PTP(I,K))**E5)           OVLL 091
      ETATT(I,K)=DELHT(I,K)/DELHTI(I,K)                                   OVLL 092
      DELHSI(I,K)=CPS(K)*TTO(I,K)*(1.-(PS2A(I,K)/PTP(I,K))**E5)           OVLL 093
      ETATS(I,K)=DELHT(I,K)/DELHSI(I,K)                                   OVLL 094
      PAT2A(I,K)=PS2A(I,K)*(1.+(GAM(5,K)-1.)*MF2A(I,K)*MF2A(I,K)          OVLL 095
     1/2.)**E3                                                            OVLL 096
      DEHATI(I,K)=CPS(K)*TTO(I,K)*(1.-(PAT2A(I,K)/PTP(I,K))**E5)          OVLL 097
      ETATAT(I,K)=DELHT(I,K)/DEHATI(I,K)                                  OVLL 098
      DELHTS(K)=DELHTS(K)+RW*DELHT(I,K)                                   OVLL 099
      DEHTIS(K)=DEHTIS(K)+RW*DELHTI(I,K)                                  OVLL 100
      DEHSIS(K)=DEHSIS(K)+RW*DELHSI(I,K)                                  OVLL 101
      DHATIS(K)=DHATIS(K)+RW*DEHATI(I,K)                                  OVLL 102
    6 CONTINUE                                                            OVLL 103
   13 SAO(K)=ALPHAO(IP,K)*57.2958                                         OVLL 104
      SIS(K)=SI(IP,K)*57.2958                                             OVLL 105
      SB1A(K)=BET1A(IP,K)*57.2958                                         OVLL 106
      SIR(K)=RI(IP,K)*57.2958                                             OVLL 107
      SA2(K)=ALF2A(IP,K)*57.2958                                          OVLL 108
      THCR(K)= GAM(1,K)*(GAMSL+1.)*RV(J,K)*STTO(K)/                       ********
     1(GAMSL*(GAM(1,K)+1.)*RSL*TSL)                                       OVLLA109
      EPSI(K)=GAMSL*((GAM(1,K)+1.)/2.)**E2/(GAM(1,K)*((GAMSL              OVLL 110
     1+1.)/2.)**E1)                                                       OVLL 111
      DELT(K)=SPTO(K)/PSL                                                 OVLL 112
      SETATT(K)=DELHTS(K)/DEHTIS(K)                                       OVLL 113
      SETATS(K)=DELHTS(K)/DEHSIS(K)                                       OVLL 114
      SETAAT(K)=DELHTS(K)/DHATIS(K)                                       OVLL 115
C     ******* CARD DELETED*********                                       ********
      SWRTP(K)= WGTO(K)*SQRT(STTO(K))/SPTO(K)                             OVLL 117
      SNRT(K)=RPM/SQRT(STTO(K))                                           OVLL 118
      SDHT(K)=DELHTS(K)/STTO(K)                                           OVLL 119
      SETHC(K)=DELHTS(K)/THCR(K)                                          OVLL 120
      RTHCR=SQRT(THCR(K))                                                 OVLL 121
      SNRTHC(K)=RPM/RTHCR                                                 OVLL 122
      SWRTED(K)=WGTO(K)*RTHCR*EPSI(K)/DELT(K)                             OVLL 123
      SPTPT2(K)=SPTO(K)/PTBAR(K)                                          OVLL 124
      SPTPS2(K)=SPTO(K)/PS2(IP,K)                                         OVLL 125
      ST2TTO(K)=TTBAR(K)/STTO(K)                                          OVLL 126
      STRTTO(K)=TTR1A(IP,K)/STTO(K)                                       OVLL 127
      UPS(K)=.5*(U1A(IP,K)+U2(IP,K))                                      OVLL 128
      UPUPS(K)=UPS(K)*UPS(K)                                              OVLL 129
      OUPUP=OUPUP+UPUPS(K)                                                OVLL 130
      URS(K)=.5*(U1A(1,K)*DR(3,K)/DP1A(1,K)+U2(1,K)*DR(4,K)/DP2(1,K))     OVLL 131
      URURS(K)=URS(K)*URS(K)                                              OVLL 132
      OURUR=OURUR+URURS(K)                                                OVLL 133
      ODELHT=ODELHT+DELHTS(K)                                             OVLL 134
```

Listing of Code (continued)

```
      IF (DELHSI(IP,K))14,14,15
   14 VIS(K)=1.
      GO TO 16
   15 VIS(K)=SQRT(2.*G*AJ*DELHSI(IP,K))
   16 UPVIS(K)=UPS(K)/VIS(K)
      URVIS(K)=URS(K)/VIS(K)
      PSIPS(K)=G*AJ*DELHTS(K)/(2.*UPUPS(K))
      PSIRS(K)=G*AJ*DELHTS(K)/(2.*URURS(K))
      RXP(K)=1.-(1.-(PS1(IP,K)/PTP(IP,K))**E5)/(1.-(PS2(IP,K)/
     1PTP(IP,K))**E5)
      VU1R=VU1(1,K)*DP1(1,K)/DR(2,K)
      V1R=SQRT(VU1R**2+VZ1(1,K)**2)
       PH1R=1./(1.-V1R**2/(2.*G*AJ*CP1(K)*TT0(1,K)*ETAS(1,K)))
      PTPS1R=PH1R**(GAM(2,K)/(GAM(2,K)-1.))*PTP(1,K)/PT0(1,K)
      RXR(K)=1.-(1.-(1./PTPS1R)**E5)/(1.-(PS2(1,K)/PTP(1,K))**E5)
      DBETAR(K)=(BET1A(1,K)+BET2E(1,K))*57.2958
      MIS(K)=V1(IP,K)/SQRT(GAM(2,K)*G*RV(2,K)*TS1(IP,K))
      TS1R=TT0(1,K)-V1R**2/(2.*G*AJ*CP1(K))
      MIRS(K)=V1R/SQRT(GAM(2,K)*G*RV(2,K)*TS1R)
      VU1AR=VU1A(1,K)*DP1A(1,K)/DR(3,K)
      V1AR=SQRT(VU1AR**2+VZ1A(1,K)**2)
      TS1AR=TT0(1,K)-V1AR**2/(2.*G*AJ*CP1A(K))
      RU1AR=VU1AR-U1A(1,K)*DR(3,K)/DP1A(1,K)
      R1AR=SQRT(RU1AR**2+VZ1A(1,K)**2)
      MR1AR(K)=R1AR/SQRT(GAM(3,K)*G*RV(3,K)*TS1AR)
      VU2T=VU2(ISECT,K)*DP2(ISECT,K)/DT(4,K)
      V2T=SQRT(VU2T**2+VZ2(ISECT,K)**2)
      TS2T=TS2(ISECT,K)+(V2(ISECT,K)**2-V2T**2)/(2.*G*AJ*CP2(K))
      RU2T=VU2T+U2(ISECT,K)*DT(4,K)/DP2(ISECT,K)
      R2T=SQRT(RU2T**2+VZ2(ISECT,K)**2)
      MR2T(K)=R2T/SQRT(GAM(4,K)*G*RV(4,K)*TS2T)
   17 CONTINUE
      IF (GAMF)4,4,7
    4 TAO=TAO/STG
      PAO=PAO/STG
      CALL GAMMA(PAO,TAO,FAIR,WAIR,GAMO)
      GO TO 8
    7 GAMO=GAMO/STG
    8 EO=(GAMO-1.)/GAMO
      RGO=RGO/STG
      CPO=RGO/EO/AJ
      K=KSTG
      ODEHTI = 0.
      ODEHSI = 0.
      ODHATI = 0.
      DO 9 I=1,ISECT
      RW=WG2A(I,K)/WGT2A(K)
```

Listing of Code (continued)

```
      ODEHTI = CPO*TTO(I,1)*(1.-(PT2A(I,K)/PTP(I,1))**EO)*RW+ODEHTI
      ODEHSI = CPO*TTO(I,1)*(1.-(PS2A(I,K)/PTP(I,1))**EO)*RW+ODEHSI
    9 ODHATI = CPO*TTO(I,1)*(1.-(PAT2A(I,K)/PTP(I,1))**EO)*RW+ODHATI
      OPSIP=G*AJ*ODELHT/(2.*OUPUP)
      OPSIR=G*AJ*ODELHT/(2.*OURUR)
      OWRTP=SWRTP(1)
      OWNED=SWRTED(1)*SNRTHC(1)/60.
      ONRTHC=SNRTHC(1)
      ONRT=SNRT(1)
      ODHT=ODELHT/TTIN
      OPTOT2=PTIN/PTBAR(KSTG)
      OPTOS2=PTIN/PS2(IP,KSTG)
      OPTAT2=PTIN/PAT2A(IP,KSTG)
      OETATT=ODELHT/ODEHTI
      OETATS=ODELHT/ODEHSI
      OETAAT=ODELHT/ODHATI
      OETHC=ODELHT/THCR(1)
C
C                        PRINT OUT FOR STAGE PERFORMANCE
      I=1
      WRITE(6,1000)NAME,TITLE,ICASE,ISCASE
 1000 FORMAT(1H1,21X,29HNASA TURBINE COMPUTER PROGRAM /6X,10A6/
     1 6X,10A6/ 30X,6HCASE  I3,1H.,I3/28X,17HSTAGE PERFORMANCE /19X
     27HSTAGE 1,6X,7HSTAGE 2,6X,7HSTAGE 3,6X,7HSTAGE 4/ )
      IF (KSTG-4)19,19,18
   18 KS=4
      GO TO 20
   19 KS=KSTG
   20 WRITE(6,1001)(STTO(K),K=I,KS)
 1001 FORMAT(2X,12H      TTBAR 02X,F10.1,3X,F10.1,3X,F10.1,3X,F10.1)
      WRITE(6,1002)(SPTO(K),K=I,KS)
 1002 FORMAT(2X,12H      PTBAR 02X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1003)(WGTO(K),K=I,KS)
 1003 FORMAT(2X,12H         WG 02X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1004)(DELHTS(K),K=I,KS)
 1004 FORMAT(2X,12H        DEL H2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1005)(SWRTP(K),K=I,KS)
 1005 FORMAT(2X,12H        WRT/P2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1006)(SDHT(K),K=I,KS)
 1006 FORMAT(2X,12H    DH/TTBAR02X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1007)(SNRT(K),K=I,KS)
 1007 FORMAT(2X,12H         N/RT2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1008)(SETATT(K),K=I,KS)
 1008 FORMAT(2X,12H       ETA TT2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1009)(SETATS(K),K=I,KS)
 1009 FORMAT(2X,12H       ETA TS2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1010)(SETAAT(K),K=I,KS)
```

Listing of Code (continued)

```
1010 FORMAT(2X,12H      ETA AT2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)      ********
     WRITE(6,1011)(PTOPS1(IP,K),K=I,KS)                                 OVLL 229
1011 FORMAT(2X,12H     PT0/PS12X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)      ********
     WRITE(6,1012)(SPTPT2(K),K=I,KS)                                    OVLL 231
1012 FORMAT(1X,13HPTBAR0/PTBAR2,2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)    ********
     WRITE(6,1013)(SPTPS2(K),K=I,KS)                                    OVLL 233
1013 FORMAT(2X,12H  PTBAR0/PS22X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)      ********
     WRITE(6,1014)(PTRS2(IP,K),K=I,KS)                                  OVLL 235
1014 FORMAT(2X,12H     PTR2/PS22X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,1015)(ST2TT0(K),K=I,KS)                                    OVLL 237
1015 FORMAT(1X,13HTTBAR2/TTBAR02X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1016)(STRTT0(K),K=I,KS)                                    OVLL 239
1016 FORMAT(2X,12HTTR1A/TTBAR02X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)      ********
     WRITE(6,2003)(WGT1(K),K=I,KS)                                      ********
2003 FORMAT(2X,12H         WG 12X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,1017)(PS1A(IP,K),K=I,KS)                                   ********
1017 FORMAT(2X,12H        PS 1A2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,1018)(TTR1A(IP,K),K=I,KS)                                  OVLL 243
1018 FORMAT(2X,12H       TTR 1A2X,F10.1,3X,F10.1,3X,F10.1,3X,F10.1)     ********
     WRITE(6,1019)(PTR1A(IP,K),K=I,KS)                                  OVLL 245
1019 FORMAT(2X,12H       PTR 1A2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,3003)(WGT1A(K),K=I,KS)                                     ********
3003 FORMAT(2X,12H        WG 1A2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,1020)(PS2(IP,K),K=I,KS)                                    OVLL 247
1020 FORMAT(2X,12H         PS 22X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,1021)(TTBAR(K),K=I,KS)                                     OVLL 249
1021 FORMAT(2X,12H      TTBAR 22X,F10.1,3X,F10.1,3X,F10.1,3X,F10.1)     ********
     WRITE(6,1022)(PTBAR(K),K=I,KS)                                     OVLL 251
1022 FORMAT(2X,12H      PTBAR 22X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,4003)(WGT2(K),K=I,KS)                                      ********
4003 FORMAT(2X,12H         WG 22X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,5003)(WGT2A(K),K=I,KS)                                     ********
5003 FORMAT(2X,12H        WG 2A2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
     WRITE(6,1023)(UPVIS(K),K=I,KS)                                     OVLL 253
1023 FORMAT(2X,12H        UP/VI2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1024)(URVIS(K),K=I,KS)                                     OVLL 255
1024 FORMAT(2X,12H        UR/VI2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1025)(PSIPS(K),K=I,KS)                                     OVLL 257
1025 FORMAT(2X,12H        PSI P2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1026)(PSIRS(K),K=I,KS)                                     OVLL 259
1026 FORMAT(2X,12H        PSI R2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1027)(RXP(K),K=I,KS)                                       OVLL 261
1027 FORMAT(2X,12H         RX P2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1028)(RXR(K),K=I,KS)                                       OVLL 263
1028 FORMAT(2X,12H         RX R2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)     ********
     WRITE(6,1029)(SA0(K),K=I,KS)                                       OVLL 265
1029 FORMAT(2X,12H      ALPHA 02X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)     ********
```

Listing of Code (continued)

```
      WRITE(6,1030)(SIS(K),K=I,KS)
 1030 FORMAT(2X,12H     I STATOR2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1031)(SB1A(K),K=I,KS)
 1031 FORMAT(2X,12H      BETA 1A2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1032)(SIR(K),K=I,KS)
 1032 FORMAT(2X,12H      I ROTOR2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1033)(SA2(K),K=I,KS)
 1033 FORMAT(2X,12H    ALPHA 2A2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1034)(DBETAR(K),K=I,KS)
 1034 FORMAT(2X,12H      DBETA R2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1035)(MIS(K),K=I,KS)
 1035 FORMAT(2X,12H           M 12X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1036)(MIRS(K),K=I,KS)
 1036 FORMAT(2X,12H         M1 RT2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1037)(MR1A(IP,K),K=I,KS)
 1037 FORMAT(2X,12H         MR 1A2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1038)(MR1AR(K), K=I,KS)
 1038 FORMAT(2X,12H      MR1A RT2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1039)(MR2(IP,K),K=I,KS)
 1039 FORMAT(2X,12H         MR 22X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1040)(MR2T(K),     K=I,KS)
 1040 FORMAT(2X,12H      MR2 TIP2X,F10.5,3X,F10.5,3X,F10.5,3X,F10.5)
      WRITE(6,1041)(SETHC(K),K=I,KS)
 1041 FORMAT(2X,12H      E/TH CR2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      WRITE(6,1042)(SNRTHC(K),K=I,KS)
 1042 FORMAT(2X,12H    N/RTH CR2X,F10.1,3X,F10.1,3X,F10.1,3X,F10.1)
      WRITE(6,1043)(SWRTED(K),K=I,KS)
 1043 FORMAT(2X,12H   WRTHCHE/D2X,F10.3,3X,F10.3,3X,F10.3,3X,F10.3)
      IF (KSTG-KS)22,22,21
   21 WRITE(6,1045)NAME,TITLE,ICASE,ISCASE
 1045 FORMAT(1H1,21X,29HNASA TURBINE COMPUTER PROGRAM /6X,10A6/
     1  6X,10A6/ 30X,6HCASE  I3,1H.,I3/28X,17HSTAGE PERFORMANCE /19X
     27HSTAGE 5,6X,7HSTAGE 6,6X,7HSTAGE 7,6X,7HSTAGE 8/ )
      I=5
      KS=KSTG
      GO TO 20
   22 WRITE(6,1044)OPSIP,OPSIR,ODELHT,OWRTP,CNRT,ODHT,OPTOT2,
     1OPTOS2,OPTAT2,OETATT,CETATS,OETAAT,OWNED,ONRTHC,OETHC
 1044 FORMAT(//31X,19HOVERALL PERFORMANCE/7X,9HPSI P
     1F10.5, 5X,10HPSI R      F10.5, 5X9HDEL H     F10.5/7X,9HWRT/P
     2F10.5, 5X,10HN/RT       F10.5, 5X9HDELH/TTINF10.5/7X,10HPT0/PTBAR2
     3F9.5,  5X,10HPT0/PS2    F10.5, 5X9HPT0/PAT2AF10.5/7X,9HETA TT
     4F10.5, 5X,10HETA TS     F10.5, 5X9HETA TAT  F10.5/7X,9HWNE/60D
     5F10.3, 5X,10HN/RTH CR   F10.3, 5X,9HE/TH CR  F10.5/)
      IF(SRFLAG) WRITE(6,20000)
20000 FORMAT(1H1,45H AN EXIT HAS BEEN MADE FROM SUBROUTINE OVRALL)
      RETURN
```

Listing of Code (continued)

```
      END                                                               OVLL 312
```

Listing of Code (continued)

```
      SUBROUTINE DIAGT(M)                                               DIGT 001
CDIAGT                                                                  DIGT 002
C                                                                       DIGT 003
      REAL MFSTOP                                                       DIGT 004
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,    DIGT 006
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   DIGT 007
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, DIGT 008
     3DELPR,PASS,IPC,LOPC,ISS                                           DIGT 009
C                                                                       DIGT 010
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)DIGT 011
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),DIGT 012
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),    DIGT 013
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)          DIGT 014
C                                                                       DIGT 015
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSI,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  DIGT 017
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARDIGT 020
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)DIGT 021
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(DIGT 022
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)DIGT 023
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              DIGT 024
C                                                                       DIGT 025
      REAL M0                                                           DIGT 026
      COMMON /SSTA01/CP0(8),                    PS0(6,8),V0(6,8),TS0(6,DIGT 027
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8), DIGT 028
     2             DPDR1(6,8),SI(6,8),  CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)DIGT 029
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8) ********
C                                                                       DIGT 031
      REAL MR1A                                                         DIGT 032
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),  DIGT 033
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6DIGT 034
     2,8),MR1A(6,8),TS1A(6,8)                                           ********
C                                                                       DIGT 036
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),DIGT 037
     1               PS2(6,8),PHI2(6,8)                                 DIGT 038
C                                                                       DIGT 039
      REAL MR2,M2      ,MF2                                             DIGT 040
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6DIGT 041
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)        DIGT 042
C                                                                       DIGT 043
      REAL M2A,MF2A                                                     DIGT 044
      COMMON /SSTA2A/WG2A(6,8),WGT2A(8),VU2A(6,8),VZ2A(6,8),PS2A(6,8),  DIGT 045
```

Listing of Code (continued)

```
     1ALF2A(6,8),TT2A(6,8),PT2A(6,8),TTBAR(8),PTBAR(8),STT0(8),SPT0(8), DIGT 046
     2M2A(6,8),MF2A(6,8),CP2A(8),V2A(6,8),TS2A(6,8),TAS(8),PAS(8),GAMS(8DIGT 047
     3),CPS(8),DELHVD(6,8),HVBAR(8)                                     ********
C                                                                       DIGT 049
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE DIAGT )           ********
      WRITE(6,1000)NAME,TITLE                                           DIGT 050
 1000 FORMAT(1H1,5X,10A6/6X,10A6/20X,29HNASA TURBINE COMPUTER PROGRAM/  DIGT 051
     131X,10HDIAGNOSTIC)                                                DIGT 052
      IF (M.EQ.0)  GO TO 10                                             DIGT 053
      GO TO (10,19,11,12,13),M                                          DIGT 054
   10 DO 14 K=1,KN                                                      DIGT 055
      WRITE(6,1001)K,CP0(K),GAM(1,K)                                    DIGT 056
 1001 FORMAT(9X,1HK,I5,9X,3HCP0,F10.3,9X,5HGAMMA,F10.5)                 DIGT 057
      WRITE(6,1002)  (PTP(I,K),I=1,ISECT)                               DIGT 058
 1002 FORMAT(3X,6H   PTP,6F10.3)                                        DIGT 059
      WRITE(6,1003)  (PT0(I,K),I=1,ISECT)                               DIGT 060
 1003 FORMAT(3X,6H   PT0,6F10.3)                                        DIGT 061
      WRITE(6,1004)  (PS0(I,K),I=1,ISECT)                               DIGT 062
 1004 FORMAT(3X,6H   PS0,6F10.3)                                        DIGT 063
      WRITE(6,1005)  (TT0(I,K),I=1,ISECT)                               DIGT 064
 1005 FORMAT(3X,6H   TT0,6F10.1)                                        DIGT 065
      WRITE(6,1006)  (TS0(I,K),I=1,ISECT)                               DIGT 066
 1006 FORMAT(3X,6H   TS0,6F10.1)                                        DIGT 067
      WRITE(6,1007)  (V0(I,K),I=1,ISECT)                                DIGT 068
 1007 FORMAT(3X,6H    V0,6F10.3)                                        DIGT 069
      WRITE(6,1008)  (ALPHA0(I,K),I=1,ISECT)                            DIGT 070
 1008 FORMAT(3X,6HALPHA0,6F10.3)                                        DIGT 071
   14 WRITE(6,1009)  (SI(I,K),I=1,ISECT)                                DIGT 072
      IF (M.EQ.0)  GO TO 19                                             DIGT 073
      GO TO 18                                                          DIGT 074
   19 DO 20 K=1,KN                                                      DIGT 075
 1009 FORMAT(3X,6H    SI,6F10.3)                                        DIGT 076
      WRITE(6,1010) K,CP1(K),GAM(2,K)                                   DIGT 077
 1010 FORMAT(9X,1HK,I5,9X,3HCP1,F10.3,9X,5HGAMMA,F10.5)                 DIGT 078
      WRITE(6,1011)  (PS1(I,K),I=1,ISECT)                               DIGT 079
 1011 FORMAT(3X,6H   PS1,6F10.3)                                        DIGT 080
      WRITE(6,1012)  (DPDR1(I,K),I=1,ISECT)                             DIGT 081
 1012 FORMAT(3X,6H DPDR1,6F10.5)                                        DIGT 082
      WRITE(6,1013)  (TS1(I,K),I=1,ISECT)                               DIGT 083
 1013 FORMAT (3X,6H   TS1,6F10.1)                                       DIGT 084
      WRITE(6,1014)  (WG1(I,K),I=1,ISECT)                               DIGT 085
 1014 FORMAT(3X,6H   WG1,6F10.3)                                        DIGT 086
      WRITE(6,1015)  (V1(I,K),I=1,ISECT)                                DIGT 087
 1015 FORMAT(3X,6H    V1,6F10.3)                                        DIGT 088
      WRITE(6,1016)  (ALF1E(I,K),I=1,ISECT)                             DIGT 089
 1016 FORMAT (3X,6H ALF1E,6F10.3)                                       DIGT 090
```

Listing of Code (continued)

```
   20 WRITE(6,1017) (ALF1(I,K),I=1,ISECT)
 1017 FORMAT(3X,6H  ALF1,6F10.3)
      IF (M.EQ.0)  GO TO 11
      GO TO 18
   11 DO 15 K=1,KN
      WRITE(6,1018) K,CP1A(K),GAM(3,K)
 1018 FORMAT(9X,1HK,I5,9X,4HCP1A,F10.3,8X,5HGAMMA,F10.5)
      WRITE(6,1019) (PTR1A(I,K),I=1,ISECT)
 1019 FORMAT(3X,6H PTR1A,6F10.3)
      WRITE(6,1020) (PS1A(I,K),I=1,ISECT)
 1020 FORMAT(3X,6H  PS1A,6F10.3)
      WRITE(6,1021) (TTR1A(I,K),I=1,ISECT)
 1021 FORMAT(3X,6H TTR1A,6F10.1)
      WRITE(6,1022) (WG1A(I,K),I=1,ISECT)
 1022 FORMAT (3X,6H  WG1A,6F10.3)
      WRITE(6,1023) (R1A(I,K),I=1,ISECT)
 1023 FORMAT (3X,6H   R1A,6F10.3)
      WRITE(6,1024) (BET1A(I,K),I=1,ISECT)
 1024 FORMAT (3X,6H BET1A,6F10.3)
   15 WRITE(6,1025) (RI(I,K),I=1,ISECT)
 1025 FORMAT (3X,6H    RI,6F10.3)
      IF (M.EQ.0)  GO TO 12
      GO TO 18
   12 DO 16 K=1,KN
      WRITE(6,1026)K,CP2(K),GAM(3,K)
 1026 FORMAT(9X,1HK,I5,9X,3HCP2,F10.3,9X,5HGAMMA,F10.5)
      WRITE(6,1027) (PTR2(I,K),I=1,ISECT)
 1027 FORMAT (3X,6H  PTR2,6F10.3)
      WRITE(6,1028) (PS2(I,K),I=1,ISECT)
 1028 FORMAT (3X,6H   PS2,6F10.3)
      WRITE(6,1029) (DPDR2(I,K),I=1,ISECT)
 1029 FORMAT (3X,6H DPDR2,6F10.5)
      WRITE(6,1030) (TTR2(I,K),I=1,ISECT)
 1030 FORMAT (3X,6H  TTR2,6F10.1)
      WRITE(6,1031) (TS2(I,K),I=1,ISECT)
 1031 FORMAT (3X,6H   TS2,6F10.1)
      WRITE(6,1032) (WG2(I,K),I=1,ISECT)
 1032 FORMAT (3X,6H   WG2,6F10.3)
      WRITE(6,1033) (R2(I,K),I=1,ISECT)
 1033 FORMAT (3X,6H    R2,6F10.3)
      WRITE(6,1034) (BET2E(I,K),I=1,ISECT)
 1034 FORMAT (3X,6H BET2E,6F10.3)
   16 WRITE(6,1035) (BET2(I,K),I=1,ISECT)
 1035 FORMAT (3X,6H  BET2,6F10.3)
      IF (M.EQ.0)  GO TO 13
      GO TO 18
   13 DO 17 K=1,KN
```

Listing of Code (continued)

```
      L=K +1                                                            DIGT 138
      WRITE(6,1036)K,CP2A(K),GAM(5,K)                                   DIGT 139
 1036 FORMAT(9X,1HK,I5,9X,4HCP2A,F10.3,8X,5HGAMMA,F10.5)                DIGT 140
      WRITE(6,1037) (PT2A(I,K),I=1,ISECT)                               DIGT 141
 1037 FORMAT (3X,6H  PT2A,6F10.3)                                       DIGT 142
      WRITE(6,1038) (PS2A(I,K),I=1,ISECT)                               DIGT 143
 1038 FORMAT (3X,6H  PS2A,6F10.3)                                       DIGT 144
      WRITE(6,1039) (TT2A(I,K),I=1,ISECT)                               DIGT 145
 1039 FORMAT (3X,6H  TT2A,6F10.1)                                       DIGT 146
      WRITE(6,1040) (TS2A(I,K),I=1,ISECT)                               DIGT 147
 1040 FORMAT (3X,6H  TS2A,6F10.1)                                       DIGT 148
      WRITE(6,1041) (WG2A(I,K),I=1,ISECT)                               DIGT 149
 1041 FORMAT (3X,6H  WG2A,6F10.3)                                       DIGT 150
      WRITE(6,1042) (V2A(I,K),I=1,ISECT)                                DIGT 151
 1042 FORMAT (3X,6H   V2A,6F10.3)                                       DIGT 152
      WRITE(6,1043) (ALF2A(I,K),I=1,ISECT)                              DIGT 153
 1043 FORMAT (3X,6H ALF2A,6F10.3)                                       DIGT 154
      WRITE(6,1044) (SI(I,K),I=1,ISECT)                                 DIGT 155
 1044 FORMAT (3X,6H    SI,6F10.3)                                       DIGT 156
      WRITE(6,1045) L,CPS(K),GAMS(K)                                    DIGT 157
 1045 FORMAT(9X,1HL,I5,9X,3HCPS,F10.3,9X,5HGAMMA,F10.5)                 DIGT 158
      WRITE(6,1046) (PTP(I,L),I=1,ISECT)                                DIGT 159
 1046 FORMAT (3X,6H   PTP,6F10.3)                                       DIGT 160
      WRITE(6,1047) (PT0(I,L),I=1,ISECT)                                DIGT 161
 1047 FORMAT (3X,6H   PT0,6F10.3)                                       DIGT 162
   17 WRITE(6,1048) (TT0(I,L),I=1,ISECT)                                DIGT 163
 1048 FORMAT (3X,6H   TT0,6F10.1)                                       DIGT 164
   18 CONTINUE                                                          DIGT 165
      IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(1H1,45H AN EXIT HAS BEEN MADE FROM SUBROUTINE DIAGT )      ********
      RETURN                                                            DIGT 166
      END                                                               DIGT 167
```

Listing of Code (continued)

```
      SUBROUTINE INSTG
CINSTG
C     INTERSTAGE OUTPUT
C      NUMBER OF SECTORS IS THREE OR LESS,HUB AND CASING VALUES ARE
C          CALCULATED AND PRINTED
C     NUMBER OF SECTORS IS MORE THAN THREE,ONLY SECTOR PITCHLINE
C          VALUES ARE PRINTED
C
      REAL MFSTOP
      LOGICAL PREVER,SRFLAG
      COMMON  SRFLAG
      COMMON /SNTCP/G,AJ,PRPC,ICASE,PREVER,MFSTOP,JUMP,LOPIN,ISCASE,
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,
     2LBRC,IBRC,ICHOKE,ISORR,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC,
     3DELPR,PASS,IPC,LOPC,ISS
C
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)
C
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSI ,
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,ENDJOB,NAME(10),TITLE(10),PCNH(6),
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETAR
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)
C
      REAL M0
      COMMON /SSTA01/CP0(8),                        PS0(6,8),V0(6,8),TS0(6,
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8),
     2              DPDR1(6,8),SI(6,8),   CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8)
C
      REAL MR1A
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6
     2,8),MR1A(6,8),TS1A(6,8)
C
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),
     1             PS2(6,8),PHI2(6,8)
C
      REAL MR2,M2      ,MF2
```

Listing of Code (continued)

```
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6INST 046
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)        INST 047
C                                                                       INST 048
      REAL M2A,MF2A                                                     INST 049
      COMMON /SSTA2A/WG2A(6,8),WGT2A(8),VU2A(6,8),VZ2A(6,8),PS2A(6,8),  INST 050
     1ALF2A(6,8),TT2A(6,8),PT2A(6,8),TTBAR(8),PTBAR(8),STT0(8),SPT0(8), INST 051
     2M2A(6,8),MF2A(6,8),CP2A(8),V2A(6,8),TS2A(6,8),TAS(8),PAS(8),GAMS(8INST 052
     3),CP0(8),DELHVD(6,8),HVBAR(8)                                     ********
C                                                                       INST 054
      COMMON /SOVRAL/DELHT(6,8),DELHTI(6,8),DELHSI(6,8),DEHATI(6,8),    INST 055
     1ETATT(6,8),ETATS(6,8),ETATAT(6,8)                                 INST 056
C                                                                       INST 057
      COMMON     STDP0(7),STPT0(7),STALF(7),STSI(7),STV0(7),STVU0(7),   INST 058
     1STVZ0(7),STTS0(7),STPS0(7),STDEN0(7),STM0(7),STDP1(7),STALFE(7),  INST 059
     2STDELA(7),STV1(7),STVU1(7),STVZ1(7),STTS1(7),STPS1(7),STDEN1(7),  INST 060
     3STM1(7),ZWIINC(7),                           CPS(7),STDP1A(7),    INST 061
     4STPTR1(7),STBET1(7),STR1(7),STR1A(7),STRU1A(7),STMR1A(7),STU1A(7),INST 062
     5STDP2(7),STHET2(7),SDBETA(7),SR2(7),SRU2(7),SMR2(7),SU2(7),RX(7), INST 063
     6STDELH(7),STPSI(7),SETATT(7),SETATS(7),SETAAT(7),RZWINC(7),       INST 064
     7                        CPR(7),STPT2A(7),STTT2A(7),STV2A(7),STVU2A(7),********
     8STALF2(7),STMF2A(7),STTTR1(7),STVZ2A(7),STTS2A(7),STPS2A(7),STDEN2********
     9(7),STM2A(7),STTT0(7),LJ,JJ,K,STWG0(7),STWG1(7),STWG1A(7),STWG2(7)********
     9,STWG2A(7),SFLO0,SFLO1,SFLO1A,SFLO2,SFLO2A,STPS1A(7),STTS1A(7),   ********
     9STPTR2(7),STTTR2(7),STPS2(7),STTS2(7)                             ********
C                                                                       INST 068
C                                                                       INST 069
      IF(SHFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE INSTG )           ********
    1 DO 9 K=1,KSTG                                                     INST 070
      SFLO0 =0.0                                                        ********
      SFLO1 =0.0                                                        ********
      SFLO1A=0.0                                                        ********
      SFLO2 =0.0                                                        ********
      SFLO2A=0.0                                                        ********
      E1=(GAMS(K)-1.)/GAMS(K)                                           INST 071
      E2=GAM(1,K)/(GAM(1,K)-1.)                                         INST 072
      E3=GAM(2,K)/(GAM(2,K)-1.)                                         INST 073
      E4=GAM(3,K)/(GAM(3,K)-1.)                                         INST 074
      E5=GAM(4,K)/(GAM(4,K)-1.)                                         INST 075
      E6=GAM(5,K)/(GAM(5,K)-1.)                                         INST 076
C     RELOCATE PITCHLINE VALUES                                         INST 077
      J=ISECT+1                                                         INST 078
    4 DO 5 I=1,ISECT                                                    INST 079
      KS=J-I+1                                                          INST 080
      STWG0(KS)=WG0(KS-1,K)                                             ********
      SFLO0 =SFLO0 +STWG0(KS)                                           ********
      STTT0(KS)=TT0(KS-1,K)                                             INST 081
```

Listing of Code (continued)

```
      STDP0(KS)=DP0(KS-1,K)                                             INST 082
      STPT0(KS)=PTP(KS-1,K)                                             INST 083
      STALF(KS)=ALPHA0(KS-1,K)*57.2958                                  INST 084
      STSI(KS)=SI(KS-1,K)*57.2958                                       INST 085
      STV0(KS)=V0(KS-1,K)                                               INST 086
      STVU0(KS)=VU0(KS-1,K)                                             INST 087
      STVZ0(KS)=VZ0(KS-1,K)                                             INST 088
      STTS0(KS)=TS0(KS-1,K)                                             INST 089
      STPS0(KS)=PS0(KS-1,K)                                             INST 090
      STDEN0(KS)=144.*STPS0(KS)/(STTS0(KS)*RV(1,K))                     ********
      STM0(KS)=M0(KS-1,K)                                               INST 092
      STWG1(KS)=WG1(KS-1,K)                                             ********
      SFLO1 =SFLO1 +STWG1(KS)                                           ********
      STDP1(KS)=DP1(KS-1,K)                                             INST 093
      STALFE(KS)=ALF1E(KS-1,K)*57.2958                                  INST 094
      STDFLA(KS)=(ALPHA0(KS-1,K)+ALF1E(KS-1,K))*57.2958                 INST 095
      STV1(KS)=V1(KS-1,K)                                               INST 096
      STVU1(KS)=VU1(KS-1,K)                                             INST 097
      STVZ1(KS)=VZ1(KS-1,K)                                             INST 098
      STTS1(KS)=TS1(KS-1,K)                                             INST 099
      STPS1(KS)=PS1(KS-1,K)                                             INST 100
      STDEN1(KS)=RHOS1(KS-1,K)                                          INST 101
      STM1(KS)=V1(KS-1,K)/(SQRT(GAM(2,K)*G*RV(2,K)*TS1(KS-1,K)))        ********
       ZS =-2.*ALF1E(KS-1,K) -1.570796                                  INST 103
      ZWIINC(KS)=COS(            ZS   )*(SIN(ALPHA0(KS-1,K))*COS(ALF1E(KSINST 104
     1-1,K))/(COS(ALPHA0(KS-1,K))*SIN(ALF1E(KS-1,K)))+1.)               INST 105
      CPS(KS)=1.-(STV0(KS)/STV1(KS))**2                                 INST 106
      STWG1A(KS)=WG1A(KS-1,K)                                           ********
      SFLO1A=SFLO1A+STWG1A(KS)                                          ********
      STDP1A(KS)=DP1A(KS-1,K)                                           INST 107
      STPTR1(KS)=PTR1A(KS-1,K)                                          INST 108
      STTTR1(KS)=TTR1A(KS-1,K)                                          INST 109
      STBET1(KS)=BET1A(KS-1,K)*57.2958                                  INST 110
      STRI(KS)=RI(KS-1,K)*57.2958                                       INST 111
      STR1A(KS)=R1A(KS-1,K)                                             INST 112
      STRU1A(KS)=RU1A(KS-1,K)                                           INST 113
      STMR1A(KS)=MR1A(KS-1,K)                                           INST 114
      STU1A(KS)=U1A(KS-1,K)                                             INST 115
      STPS1A(KS)=PS1A(KS-1,K)                                           ********
      STTS1A(KS)=TS1A(KS-1,K)                                           ********
      STWG2(KS)=WG2(KS-1,K)                                             ********
      SFLO2 =SFLO2 +STWG2(KS)                                           ********
      STDP2(KS)=DP2(KS-1,K)                                             INST 116
      STBET2(KS)=BET2E(KS-1,K)*57.2958                                  INST 117
      SDBETA(KS)=(BET1A(KS-1,K)+BET2E(KS-1,K))*57.2958                  INST 118
      SR2(KS)=R2(KS-1,K)                                                INST 119
      SRU2(KS)=RU2(KS-1,K)                                              INST 120
```

Listing of Code (continued)

```
                                                                     INST 121
      SU2(KS)=U2(KS-1,K)                                             INST 122
      STPTR2(KS)=PTR2(KS-1,K)                                        ********
      STTTR2(KS)=TTR2(KS-1,K)                                        ********
      RX(KS)=1.-(1.-(PS1(KS-1,K)/PTP(KS-1,K))**E1)/(1.-(PS2(KS-1,K)/ INST 123
     1PTP(KS-1,K))**E1)                                              INST 124
      STDELH(KS)=DELHT(KS-1,K)                                       INST 125
      STPSI(KS)=2.*G*AJ*DELHT(KS-1,K)/(U1A(KS-1,K)*U1A(KS-1,K)       INST 126
     1+U2(KS-1,K)*U2(KS-1,K))                                        INST 127
      SETATT(KS)=ETATT(KS-1,K)                                       INST 128
      SETATS(KS)=ETATS(KS-1,K)                                       INST 129
      SETAAT(KS)=ETATAT(KS-1,K)                                      INST 130
      ZR = -2.*BET2E(KS-1,K) -1.570796                               INST 131
      RZWINC(KS)=COS(          ZR )*(SIN(BET1A(KS-1,K))*COS(BET2E(KS-INST 132
     11,K))/(COS(BET1A(KS-1,K))*SIN(BET2E(KS-1,K)))+1.)              INST 133
      CPR(KS)=1.-(STR1A(KS)/SR2(KS))**2                              INST 134
      STPS2(KS)=PS2(KS-1,K)                                          ********
      STTS2(KS)=TS2(KS-1,K)                                          ********
      STWG2A(KS)=WG2A(KS-1,K)                                        ********
      SFLO2A=SFLO2A+STWG2A(KS)                                       ********
      STPT2A(KS)=PT2A(KS-1,K)                                        ********
      STTT2A(KS)=TT2A(KS-1,K)                                        ********
      STV2A(KS)=V2A(KS-1,K)                                          ********
      STVU2A(KS)=VU2A(KS-1,K)                                        ********
      STALF2(KS)=ALF2A(KS-1,K)*57.2958                               INST 139
      STMF2A(KS)=MF2A(KS-1,K)                                        ********
      STVZ2A(KS)=VZ2A(KS-1,K)                                        ********
      STPS2A(KS)=PS2A(KS-1,K)                                        ********
      STTS2A(KS)=TS2A(KS-1,K)                                        ********
      STM2A(KS)=M2A(KS-1,K)                                          ********
      STDEN2(KS)=144.*STPS2A(KS)/(STTS2A(KS)*RV(5,K))                ********
    5 CONTINUE                                                       INST 146
      IF (ISECT-3)3,3,6                                              INST 147
C        CALCULATE HUB VALUES                                        INST 148
    3 LJ=1                                                           INST 149
      JJ=ISECT+2                                                     INST 150
      I=1                                                            INST 151
      L=1                                                            INST 152
      STDP0(L)=DR(1,K)                                               ********
      R1=DP0(I,K)/DR(1,K)                                            ********
      STDP1(L)=DR(2,K)                                               ********
      R2=DP1(I,K)/DR(2,K)                                            INST 156
      STDP1A(L)=DR(3,K)                                              ********
      R3=DP1A(I,K)/DR(3,K)                                           INST 158
      STDP2(L)=DR(4,K)                                               INST 159
      R4=DP2(I,K)/DR(4,K)                                            ********
      TALF=SIN(ALF1(I,K))*R3/COS(ALF1(I,K))                          INST 161
```

Listing of Code (continued)

```
      R5=CP2A(I,K)/DR(5,K)
C        STATION    0          STATOR  INLET
   10 STTT0(L)=TT0(I,K)
      STPT0(L)=PTP(I,K)
      STVZ0(L)=VZ0(I,K)
      STVU0(L)=VU0(I,K)*R1
      STV0(L)=SQRT(VZ0(I,K)*VZ0(I,K)+STVU0(L)*STVU0(L))
      STTS0(L)=TT0(I,K)-STV0(L)*STV0(L)/(2.*G*AJ*CP0(K))
      STPS0(L)=PS0(I,K)*(STTS0(L)/TS0(I,K))**E2
      STDEN0(L)=144.*STPS0(L)/(RV(1,K)*STTS0(L))
       STALF(L)=ATAN2(STVU0(L),STVZ0(L))*57.2958
      STSI(L)=STALF(L)-ATAN2(SIN( RADSD(I,K))*R1,COS( RADSD(I,K)))
     1*57.2958
      AS0H=SQRT(GAM(1,K)*G*RV(1,K)*STTS0(L))
      STM0(L)=STV0(L)/AS0H
C        STATION    1          STATOR  EXIT
      STVZ1(L)=VZ1(I,K)
      STVU1(L)=VU1(I,K)*R2
      STV1(L)=SQRT(VZ1(I,K)*VZ1(I,K)+STVU1(L)*STVU1(L))
      STTS1(L)=TT0(I,K)-STV1(L)*STV1(L)/(2.*G*AJ*CP1(K))
      STPS1(L)=PS1(I,K)*(STTS1(L)/TS1(I,K))**E3
      STDEN1(L)=144.*STPS1(L)/STTS1(L)/RV(2,K)
      STALFE(L)=ATAN2(STVU1(L),STVZ1(L))*57.2958
      STDELA(L)=STALF(L)+STALFE(L)
      AS1H=SQRT(GAM(2,K)*G*RV(2,K)*STTS1(L))
      STM1(L)=STV1(L)/AS1H
      ZS =-2.*STALFE(L)/ 57.2958 -1.570796
      ZWIINC(L)= COS(   ZS)*(STVU0(L)*STVZ1(L)  /(STVZ0(L)*STVU1(L))+1.)
      CPS(L)=1.-(STV0(L)/STV1(L))**2
C        STATION    1A         ROTOR    INLET
      VU1AH=VU1A(I,K)*R3
      STRU1A(L)=VU1AH-U1A(I,K)/R3
      STBET1(L)=ATAN2(STRU1A(L),VZ1A(I,K))*57.2958
      T=TALF-(TALF/R3 - SIN(RADRD(I,K))/COS(RADRD(I,K)))/R3
      STRI(L)=STBET1(L)-ATAN2(     T,1.      )*57.2958
      STR1A(L)=SQRT(STRU1A(L)*STRU1A(L)+VZ1A(I,K)*VZ1A(I,K))
      V1A1AH=VZ1A(I,K)*VZ1A(I,K)+VU1AH*VU1AH
      DELTSH=(V1(I,K)*V1(I,K)-V1A1AH)/(2.*G*AJ*CP1A(K))
      TS1AH=TS1(I,K)+DELTSH
      STTS1A(L)=TS1AH
      STMR1A(L)=STR1A(L)/SQRT(GAM(3,K)*G*RV(3,K)*TS1AH)
      TTRSH=1.+STMR1A(L)*STMR1A(L)*(GAM(3,K)-1.)/2.
      STTTR1(L)=TS1AH*TTRSH
      IF (RI(I,K))2,2,7
    2 EXPRI=EXPN
      GO TO 11
    7 EXPRI=EXPP
```

Listing of Code (continued)

```
   11 PTRSH=(1.+(TTRSH-1.)*ETARR(I,K)*COS(RI(I,K))**EXPRI)**E4                INST 208
      PS1AH=PS1(I,K)*(1.+DELTSH/TS1(I,K))**E4                                 INST 209
      STPS1A(L)=PS1AH                                                         ********
      STPTR1(L)=PS1AH*PTRSH                                                   INST 210
      STU1A(L)=U1A(I,K)/R3                                                    INST 211
C         STATION    2          ROTOR     EXIT                                INST 212
      VU2H=VU2(I,K)*R4                                                        INST 213
      SHU2(L)=VU2H+U2(I,K)/R4                                                 INST 214
      STBET2(L)=ATAN2(SHU2(L),VZ2(I,K))*57.2958                               INST 215
      SDBETA(L)=STBET1(L)+STBET2(L)                                           INST 216
      SR2(L)=SQRT(SHU2(L)*SHU2(L)+VZ2(I,K)*VZ2(I,K))                          INST 217
      V2V2H=VZ2(I,K)*VZ2(I,K)+VU2H*VU2H                                       INST 218
      DELTSH=(V2(I,K)*V2(I,K)-V2V2H)/(2.*G*AJ*CP2(K))                         INST 219
      TS2H=TS2(I,K)+DELTSH                                                    INST 220
      STTS2(L)=TS2H                                                           ********
      SMR2(L)=SR2(L)/SQRT(GAM(4,K)*G*RV(4,K)*TS2H)                            ********
      SU2(L)=U2(I,K)/R4                                                       INST 222
      PS2H=PS2(I,K)*(TS2H/TS2(I,K))**E5                                       INST 223
      STPS2(L)=PS2H                                                           ********
      RX(L)=1.-(1.-(STPS1(L)/PTP(I,K))**E1)/(1.-(PS2H/PTP(I,K))**E1)          INST 224
      STDELH(L)=(STU1A(L)*VU1AH+SU2(L)*VU2H)*TFR(I,K)/(    G*AJ)              INST 225
      STPSI(L)=2.*G*AJ*STDELH(L)/(STU1A(L)**2+SU2(L)**2)                      INST 226
      SETATT(L)=STDELH(L)/DELHTI(I,K)                                         INST 227
      SETATS(L)=STDELH(L)/DELHSI(I,K)                                         INST 228
      SETAAT(L)=STDELH(L)/DEHATI(I,K)                                         INST 229
      ZR =-2.*STBET2(L)/57.2958 -1.570796                                     INST 230
      RZWINC(L)=COS(    ZR)*(STRU1A(L)*VZ2(I,K)  /(VZ1A(I,K)*SRU2(L))+1.)     INST 231
      CPR(L)=1.-(STR1A(L)/SR2(L))**2                                          INST 232
      STPT2A(L)=PT2A(I,K)                                                     ********
      STTT2A(L)=TT2A(I,K)                                                     ********
      STVZ2A(L)=VZ2A(I,K)                                                     ********
      STVU2A(L)=VU2A(I,K)*R5                                                  ********
      V2A2AH=STVU2A(L)**2+VZ2A(I,K)**2                                        ********
      STV2A(L)=SQRT(V2A2AH)                                                   ********
      STALF2(L)=ATAN2(STVU2A(L),VZ2A(I,K))*57.2958                            ********
      DELTS2=(V2A(I,K)**2-V2A2AH)/(2.*G*AJ*CP2A(K))                           INST 240
      STTS2A(L)=TS2A(I,K)+DELTS2                                              ********
      STPS2A(L)=PS2A(I,K)*(1.+DELTS2/TS2A(I,K))**E6                           ********
      STDEN2(L)=144.*STPS2A(L)/(RV(5,K)*STTS2A(L))                            ********
      STM2A(L)=STV2A(L)/SQRT(GAM(5,K)*G*RV(5,K)*STTS2A(L))                    ********
      STMF2A(L)=STM2A(L)*COS(STALF2(L)/57.2958)                               ********
      IF (L.GT.1) GO TO 8                                                     INST 246
C          CALCULATE   TIP    VALUES                                          INST 247
      I=ISECT                                                                 INST 248
      L=ISECT+2                                                               INST 249
      STDP0(L)=DT(1,K)                                                        INST 250
      R1=DP0(I,K)/DT(1,K)                                                     INST 251
```

Listing of Code (continued)

```
      STDP1(L)=DT(2,K)                                                  INST 252
      R2=CP1(I,K)/DT(2,K)                                               INST 253
      STDP1A(L)=DT(3,K)                                                 INST 254
      R3=CP1A(I,K)/DT(3,K)                                              INST 255
      STDP2(L)=DT(4,K)                                                  INST 256
      R4=CP2(I,K)/DT(4,K)                                               INST 257
      TALF=SIN(ALF1(I,K))*R3/COS(ALF1(I,K))                             INST 258
      R5=CP2A(I,K)/DT(5,K)                                              INST 259
      GO TO 10                                                          INST 260
    6 LJ=2                                                              INST 261
      JJ=ISECT+1                                                        INST 262
    8 CALL WOUT                                                         INST 263
    9 CONTINUE                                                          INST 264
      IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE INSTG )          ********
      RETURN                                                            INST 265
      END                                                               INST 266
```

Listing of Code (continued)

```
      SUBROUTINE WOUT                                                   WOUT 001
CWOUT                                                                   WOUT 002
C                                                                       WOUT 003
      REAL MFSTOP                                                       WOUT 004
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      COMMON /SNTCP/G,AJ,PRFC,ICASE,PRFVER,MFSTOP,JUMP,LOPIN,ISCASE,    WOUT 006
     1KN,GAMF,IP,SCRIT,PTRN,ISECT,KSTG,WTOL,RHOTOL,PRTOL,TRLOOP,LSTG,   WOUT 007
     2LBRC,IBRC,ICHOKE,ISORH,CHOKE,PTOPS1(6,8),PTRS2(6,8),TRDIAG,SC,RC, WOUT 008
     3DELPR,PASS,IPC,LOPC,ISS                                           WOUT 009
C                                                                       WOUT 010
      COMMON /SINIT/H1(6,8),H2(6,8),DP0(6,8),DP1(6,8),DP1A(6,8),DP2(6,8)WOUT 011
     1,DP2A(6,8),CSALF1(6,8),ALF1(6,8),CSBET2(6,8),BET2(6,8),RADSD(6,8),WOUT 012
     2RADRD(6,8),ANN1(6,8),ANN2(6,8),ANN2A(6,8),ANN1A(6,8),U1A(6,8),    WOUT 013
     3U2(6,8),ANN0(6,8),PT0(6,8),TT0(6,8),ALPHA0(6,8),PTP(6,8)          WOUT 014
C                                                                       WOUT 015
      COMMON /SINPUT/ RSL,TSL,PSL,GAMSL,                                ********
     1PTPS,PTIN,TTIN,WAIR,FAIR,DELC,DELL,DELA,AACS,VCTD,STG,SECT,EXPN,  WOUT 017
     2EXPP,EXPRE,    RPM,PAF,SLI,STGCH,FNDJOB,NAME(10),TITLE(10),PCNH(6),********
     3RV(6,8),GAM(6,8),DR(6,8),DT(6,8),RWG(6,8),ALPHAS(6,8),ALPHA1(6,8),********
     4ETARS(6,8),ETAS(6,8),CFS(6,8),ANDO(6,8),BETA1(6,8),BETA2(6,8),ETARWOUT 020
     5R(6,8),ETAR(6,8),CFR(6,8),TFR(6,8),ANDOR(6,8),OMEGAS(6,8),AS0(6,8)WOUT 021
     6,ASMP0(6,8),ACMN0(6,8),A1(6,8),A2(6,8),A3(6,8),A4(6,8),A5(6,8),A6(WOUT 022
     76,8),OMEGAR(6,8),BSIA(6,8),BSMPIA(6,8),BCMNIA(6,8),B1(6,8),B2(6,8)WOUT 023
     8,B3(6,8),B4(6,8),B5(6,8),B6(6,8),SESTHI(8),RERTHI(8)              WOUT 024
C                                                                       ********
      REAL M0                                                           ********
      COMMON /SSTA01/CP0(8),                      PS0(6,8),V0(6,8),TS0(6,********
     18),VU0(6,8),VZ0(6,8),RHOS0(6,8),PS1(6,8),WGT1(8),TA1(8),WG1(6,8), ********
     2            DPDR1(6,8),SI(6,8),   CP1(8),PHI1(6,8),TS1(6,8),V1(6,8)********
     3,RHOS1(6,8),ALF1E(6,8),VU1(6,8),VZ1(6,8),M0(6,8),WGT0(8),WG0(6,8) ********
C                                                                       ********
      REAL MR1A                                                         ********
      COMMON /SSTA1A/VU1A(6,8),WG1A(6,8),WGT1A(8),VZ1A(6,8),  CP1A(8),  ********
     1PS1A(6,8),RU1A(6,8),R1A(6,8),BET1A(6,8),RI(6,8),TTR1A(6,8),PTR1A(6********
     2,8),MR1A(6,8),TS1A(6,8)                                           ********
C                                                                       ********
      COMMON /SSTA2/V2(6,8),TTR2(6,8),PTR2(6,8),WG2(6,8),WGT2(8),TA2(8),********
     1            PS2(6,8),PHI2(6,8)                                    ********
C                                                                       ********
      REAL MR2,M2,MF                                                    ********
      COMMON /SFLOW2/TS2(6,8),CP2(8),R2(6,8),RHOS2(6,8),BET2E(6,8),RU2(6********
     1,8),VU2(6,8),DPDR2(6,8),VZ2(6,8),MR2(6,8),MF2(6,8),M2(6,8)        ********
C                                                                       ********
      REAL M2A,MF2A                                                     ********
      COMMON /SSTA2A/WG2A(6,8),WGT2A(8),VU2A(6,8),VZ2A(6,8),PS2A(6,8),  ********
```

Listing of Code (continued)

```
     1ALF2A(6,8),TT2A(6,8),PT2A(6,8),TTBAR(8),PTBAR(8),STT0(8),SPT0(8), ********
     2M2A(6,8),MF2A(6,8),CP2A(8),V2A(6,8),TS2A(6,8),TAS(8),PAS(8),GAMS(8********
     3),CP0(8),DELHVD(6,8),HVBAR(8)                                      ********
C                                                                        ********
      COMMON /SOVRAL/DELHT(6,8),DELHTI(6,8),DELHSI(6,8),DEHATI(6,8),     ********
     1ETATT(6,8),ETATS(6,8),ETATAT(6,8)                                  ********
C                                                                        WOUT 025
      COMMON     STDP0(7),STPT0(7),STALF(7),STSI(7),STV0(7),STVU0(7),   WOUT 026
     1STVZ0(7),STTS0(7),STPS0(7),STDEN0(7),STM0(7),STDP1(7),STALFE(7),  WOUT 027
     2STDELA(7),STV1(7),STVU1(7),STVZ1(7),STTS1(7),STPS1(7),STDEN1(7),  WOUT 028
     3STM1(7),ZWIINC(7),                     CPS(7),STDP1A(7),          WOUT 029
     4STPTR1(7),STBET1(7),SIRI(7),STR1A(7),STRU1A(7),STMR1A(7),STU1A(7),WOUT 030
     5STDP2(7),STHET2(7),SDBETA(7),SR2(7),SRU2(7),SMR2(7),SU2(7),RX(7), WOUT 031
     6STDELH(7),STPSI(7),SETATT(7),SETATS(7),SETAAT(7),RZWINC(7),       WOUT 032
     7                        CPR(7),STPT2A(7),STTT2A(7),STV2A(7),STVU2A(7),********
     8STALF2(7),STMF2A(7),SITTR1(7),STVZ2A(7),STTS2A(7),STPS2A(7),STDEN2********
     9(7),STM2A(7),STTT0(7),LJ,JJ,K,STWG0(7),STWG1(7),STWG1A(7),STWG2(7)********
     9,STWG2A(7),SFLO0,SFLO1,SFLO1A,SFLO2,SFLO2A,STPS1A(7),STTS1A(7),   ********
     9STPTR2(7),STTTR2(7),STPS2(7),STTS2(7)                              ********
C                                                                        WOUT 036
C         PRINT  OUT  FOR  INTERSTAGE  DATA                              WOUT 037
      IF(SRFLAG) WRITE(6,10000)                                          ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE WOUT  )            ********
    8 WRITE(6,1000)NAME,TITLE,ICASE,ISCASE                               WOUT 038
 1000 FORMAT(1H1,20X29HNASA TURBINE COMPUTER PROGRAM/6X10A6/6X10A6/30X   WOUT 039
     15HCASE I3,1H.I3/24X23HINTER-STAGE PERFORMANCE//)                   WOUT 040
      WRITE(6,1001)K,(STDP0(I),I=LJ,JJ)                                  WOUT 041
 1001 FORMAT(5X5HSTA 02X12HSTATOR INLET10X5HSTAGEI3,1H./4X6HDIAM 02X,    WOUT 042
     16F10.3)                                                            WOUT 043
      WRITE(6,1002)(STTT0(I),I=LJ,JJ)                                    WOUT 044
 1002 FORMAT (10H        TT 0,2X,6F10.1)                                 WOUT 045
      WRITE(6,1003)( STPT0(I),I=LJ,JJ)                                   WOUT 046
 1003 FORMAT (10H        PT 0,2X,6F10.3)                                 WOUT 047
      WRITE(6,1004)( STALF(I),I=LJ,JJ)                                   WOUT 048
 1004 FORMAT (10H   ALPHA 0,2X,6F10.3)                                   WOUT 049
      WRITE(6,1005)(  STSI(I),I=LJ,JJ)                                   WOUT 050
 1005 FORMAT (10H  I STATOR,2X,6F10.3)                                   WOUT 051
      WRITE(6,1006)(  STV0(I),I=LJ,JJ)                                   WOUT 052
 1006 FORMAT (10H         V 0,2X,6F10.3)                                 WOUT 053
      WRITE(6,1007)( STVU0(I),I=LJ,JJ)                                   WOUT 054
 1007 FORMAT (10H        VU 0,2X,6F10.3)                                 WOUT 055
      WRITE(6,1008)( STVZ0(I),I=LJ,JJ)                                   WOUT 056
 1008 FORMAT (10H        VZ 0,2X,6F10.3)                                 WOUT 057
      WRITE(6,1009)( STTS0(I),I=LJ,JJ)                                   WOUT 058
 1009 FORMAT (10H        TS 0,2X,6F10.1)                                 WOUT 059
      WRITE(6,1010)( STPS0(I),I=LJ,JJ)                                   WOUT 060
 1010 FORMAT (10H        PS 0,2X,6F10.3)                                 WOUT 061
```

Listing of Code (continued)

```
      WRITE(6,1011)(STDEN0(I),I=LJ,JJ)                                  WOUT 062
 1011 FORMAT (10H    DENS 0,2X,6F10.5)                                  WOUT 063
      WRITE(6,1012)(   STM0(I),I=LJ,JJ)                                 WOUT 064
 1012 FORMAT (10H       M 0,2X,6F10.5)                                  ********
      WRITE(6,1999)( CP0(K),I=LJ,JJ)                                    ********
 1999 FORMAT(10H      CP 0,2X,6F10.5)                                   ********
      WRITE(6,2000)(RV(1,K),I=LJ,JJ)                                    ********
 2000 FORMAT (10H      RG 0,2X,6F10.3)                                  ********
      WRITE(6,2001)(GAM(1,K),I=LJ,JJ)                                   ********
 2001 FORMAT (10H    GAMG 0,2X,6F10.5)                                  ********
      WRITE (6,2002)(RWG(1,K),I=LJ,JJ)                                  ********
 2002 FORMAT (10H     RWG 0,2X,6F10.5)                                  ********
      IF(ISECT.LE.3)GO TO 11013                                         ********
      WRITE(6,2003)( STWG0(I),I=LJ,JJ),SFLOO                            ********
 2003 FORMAT (10H      WG 0,2X,6F10.5,2X,11HTOTAL FLOW ,F10.5)          ********
11013 WRITE(6,1013)(STDP1(I),I=LJ,JJ)                                   ********
 1013 FORMAT(/5X5HSTA 12X11HSTATOR EXIT/4X6HDIAM 12X,6F10.3)            WOUT 067
      WRITE(6,1014)(STALFE(I),I=LJ,JJ)                                  WOUT 068
 1014 FORMAT (10H   ALPHA 1,2X,6F10.3)                                  WOUT 069
      WRITE(6,1015)(STDELA(I),I=LJ,JJ)                                  WOUT 070
 1015 FORMAT (10H     DEL A,2X,6F10.3)                                  WOUT 071
      WRITE(6,1016)(   STV1(I),I=LJ,JJ)                                 WOUT 072
 1016 FORMAT (10H       V 1,2X,6F10.3)                                  WOUT 073
      WRITE(6,1017)( STVU1(I),I=LJ,JJ)                                  WOUT 074
 1017 FORMAT (10H      VU 1,2X,6F10.3)                                  WOUT 075
      WRITE(6,1018)( STVZ1(I),I=LJ,JJ)                                  WOUT 076
 1018 FORMAT (10H      VZ 1,2X,6F10.3)                                  WOUT 077
      WRITE(6,1019)( STTS1(I),I=LJ,JJ)                                  WOUT 078
 1019 FORMAT (10H      TS 1,2X,6F10.1)                                  WOUT 079
      WRITE(6,1064)( STPS1(I),I=LJ,JJ)                                  WOUT 080
 1064 FORMAT (10H      PS 1,2X,6F10.3)                                  WOUT 081
      WRITE(6,1020)(STDEN1(I),I=LJ,JJ)                                  WOUT 082
 1020 FORMAT (10H    DENS 1,2X,6F10.5)                                  WOUT 083
      WRITE(6,1021)(   STM1(I),I=LJ,JJ)                                 WOUT 084
 1021 FORMAT (10H       M 1,2X,6F10.5)                                  WOUT 085
      WRITE(6,1022)(ZWIINC(I),I=LJ,JJ)                                  WOUT 086
 1022 FORMAT (10H   ZWI INC,2X,6F10.5)                                  ********
      WRITE(6,1026)(    CPS(I),I=LJ,JJ)                                 WOUT 088
 1026 FORMAT (10H      CP S,2X,6F10.5)                                  ********
      WRITE(6,2999)( CP1(K),I=LJ,JJ)                                    ********
 2999 FORMAT(10H      CP 1,2X,6F10.5)                                   ********
      WRITE(6,3000)(RV(2,K),I=LJ,JJ)                                    ********
 3000 FORMAT (10H      RG 1,2X,6F10.3)                                  ********
      WRITE(6,3001)(GAM(2,K),I=LJ,JJ)                                   ********
 3001 FORMAT (10H    GAMG 1,2X,6F10.5)                                  ********
      WRITE (6,3002)(RWG(2,K),I=LJ,JJ)                                  ********
 3002 FORMAT (10H     RWG 1,2X,6F10.5)                                  ********
```

Listing of Code (continued)

```
      IF(ISECT.LE.3)GO TO 11000                                          ********
      WRITE(6,3003)( STWG1(I),I=LJ,JJ),SFLO1                             ********
 3003 FORMAT (10H      WG 1,2X,6F10.5,2X,11HTOTAL FLOW ,F10.5)           ********
11000 WRITE(6,1000)NAME,TITLE,ICASE,ISCASE                               ********
      WRITE(6,1028)K,(STDP1A(I),I=LJ,JJ)                                 WOUT 091
 1028 FORMAT(4X6HSTA 1A2X11HROTOR INLET10X5HSTAGEI3,1H./3X7HDIAM 1A2X,   WOUT 092
     16F10.3)                                                            WOUT 093
      WRITE(6,1027)(STPTR1(I),I=LJ,JJ)                                   WOUT 094
 1027 FORMAT (10H     PTR 1A,2X,6F10.3)                                  WOUT 095
      WRITE(6,1029)(STTTR1(I),I=LJ,JJ)                                   WOUT 096
 1029 FORMAT (10H     TTR 1A,2X,6F10.1)                                  WOUT 097
      WRITE(6,1030)(STBET1(I),I=LJ,JJ)                                   WOUT 098
 1030 FORMAT (10H    BETA 1A,2X,6F10.3)                                  WOUT 099
      WRITE(6,1031)(  STRI(I),I=LJ,JJ)                                   WOUT 100
 1031 FORMAT (10H    I ROTOR,2X,6F10.3)                                  WOUT 101
      WRITE(6,1032)( STR1A(I),I=LJ,JJ)                                   WOUT 102
 1032 FORMAT (10H       R 1A,2X,6F10.3)                                  WOUT 103
      WRITE(6,1033)(STRU1A(I),I=LJ,JJ)                                   WOUT 104
 1033 FORMAT (10H      RU 1A,2X,6F10.3)                                  WOUT 105
      WRITE(6,1034)(STMR1A(I),I=LJ,JJ)                                   WOUT 106
 1034 FORMAT (10H      MR 1A,2X,6F10.5)                                  WOUT 107
      WRITE(6,1035)( STU1A(I),I=LJ,JJ)                                   WOUT 108
 1035 FORMAT (10H       U 1A,2X,6F10.3)                                  WOUT 109
      WRITE (6,2035)(STPS1A(I),I=LJ,JJ)                                  ********
 2035 FORMAT (10H      PS 1A,2X,6F10.3)                                  ********
      WRITE (6,2036)(STTS1A(I),I=LJ,JJ)                                  ********
 2036 FORMAT (10H      TS 1A,2X,6F10.1)                                  ********
      WRITE(6,3999)(CP1A(K),I=LJ,JJ)                                     ********
 3999 FORMAT(10H      CP 1A,2X,6F10.5)                                   ********
      WRITE(6,4000)(RV(3,K),I=LJ,JJ)                                     ********
 4000 FORMAT (10H      RG 1A,2X,6F10.3)                                  ********
      WRITE(6,4001)(GAM(3,K),I=LJ,JJ)                                    ********
 4001 FORMAT (10H    GAMG 1A,2X,6F10.5)                                  ********
      WRITE (6,4002)(RWG(3,K),I=LJ,JJ)                                   ********
 4002 FORMAT (10H     RWG 1A,2X,6F10.5)                                  ********
      IF(ISECT.LE.3)GO TO 11037                                          ********
      WRITE(6,4003)(STWG1A(I),I=LJ,JJ),SFLO1A                            ********
 4003 FORMAT (10H      WG 1A,2X,6F10.5,2X,11HTOTAL FLOW ,F10.5)          ********
11037 WRITE(6,1037)(STDP2(I),I=LJ,JJ)                                    ********
 1037 FORMAT(/5X5HSTA 22X10HROTOR EXIT/4X6HDIAM 22X,6F10.3)              WOUT 111
      IF(ISECT.LE.3)GO TO 11036                                          ********
      WRITE (6,2037)(STPTR2(I),I=LJ,JJ)                                  ********
 2037 FORMAT (10H     PTR 2,2X,6F10.3)                                   ********
      WRITE (6,2038)(STTTR2(I),I=LJ,JJ)                                  ********
 2038 FORMAT (10H     TTR 2,2X,6F10.1)                                   ********
11036 WRITE(6,1036)(STHET2(I),I=LJ,JJ)                                   ********
 1036 FORMAT (10H    BETA 2,2X,6F10.3)                                   WOUT 113
```

Listing of Code (continued)

```
      WRITE(6,1038)(SDBETA(I),I=LJ,JJ)                                   WOUT 114
 1038 FORMAT (10H      DBETA,2X,6F10.3)                                  WOUT 115
      WRITE(6,1039)(    SR2(I),I=LJ,JJ)                                  WOUT 116
 1039 FORMAT (10H       R 2,2X,6F10.3)                                   WOUT 117
      WRITE(6,1040)(   SRU2(I),I=LJ,JJ)                                  WOUT 118
 1040 FORMAT (10H      RU 2,2X,6F10.3)                                   WOUT 119
      WRITE(6,1041)(   SMR2(I),I=LJ,JJ)                                  WOUT 120
 1041 FORMAT (10H      MR 2,2X,6F10.5)                                   WOUT 121
      WRITE(6,1042)(    SU2(I),I=LJ,JJ)                                  WOUT 122
 1042 FORMAT (10H       U 2,2X,6F10.3)                                   WOUT 123
      WRITE(6,1043)(     RX(I),I=LJ,JJ)                                  WOUT 124
 1043 FORMAT (10H         RX,2X,6F10.5)                                  WOUT 125
      WRITE(6,1044)(STDELH(I),I=LJ,JJ)                                   WOUT 126
 1044 FORMAT (10H       DELH,2X,6F10.3)                                  WOUT 127
      WRITE(6,1045)( STPSI(I),I=LJ,JJ)                                   WOUT 128
 1045 FORMAT (10H      PSI P,2X,6F10.5)                                  WOUT 129
      WRITE(6,1046)(SETATT(I),I=LJ,JJ)                                   WOUT 130
 1046 FORMAT (10H     ETA TT,2X,6F10.5)                                  WOUT 131
      WRITE(6,1047)(SETATS(I),I=LJ,JJ)                                   WOUT 132
 1047 FORMAT (10H     ETA TS,2X,6F10.5)                                  WOUT 133
      WRITE(6,1048)(SETAAT(I),I=LJ,JJ)                                   WOUT 134
 1048 FORMAT (10H     ETA AT,2X,6F10.5)                                  WOUT 135
      WRITE(6,1049)(RZWINC(I),I=LJ,JJ)                                   WOUT 136
 1049 FORMAT (10H    ZWI INC,2X,6F10.5)                                  ********
      WRITE(6,1065)(    CPR(I),I=LJ,JJ)                                  WOUT 138
 1065 FORMAT (10H       CP R,2X,6F10.5)                                  ********
      WRITE (6,2065)( STPS2(I),I=LJ,JJ)                                  ********
 2065 FORMAT (10H       PS 2,2X,6F10.3)                                  ********
      WRITE (6,2066)( STTS2(I),I=LJ,JJ)                                  ********
 2066 FORMAT (10H       TS 2,2X,6F10.1)                                  ********
      WRITE(6,4999)( CP2(K),I=LJ,JJ)                                     ********
 4999 FORMAT(10H       CP 2,2X,6F10.5)                                   ********
      WRITE(6,5000)(RV(4,K),I=LJ,JJ)                                     ********
 5000 FORMAT (10H       RG 2,2X,6F10.3)                                  ********
      WRITE(6,5001)(GAM(4,K),I=LJ,JJ)                                    ********
 5001 FORMAT (10H     GAMG 2,2X,6F10.5)                                  ********
      WRITE (6,5002)(RWG(4,K),I=LJ,JJ)                                   ********
 5002 FORMAT (10H      RWG 2,2X,6F10.5)                                  ********
      IF(ISECT.LE.3)GO TO 11053                                          ********
      WRITE(6,5003)( STWG2(I),I=LJ,JJ),SFLO2                             ********
 5003 FORMAT (10H       WG 2,2X,6F10.5,2X,11HTOTAL FLOW ,F10.5)          ********
11053 WRITE(6,1053)( STPT2A(I),I=LJ,JJ)                                  ********
 1053 FORMAT (10H      PT 2A,2X,6F10.3)                                  WOUT 141
      WRITE(6,1054)( STTT2A(I),I=LJ,JJ)                                  ********
 1054 FORMAT (10H      TT 2A,2X,6F10.1)                                  WOUT 143
      WRITE(6,1055)(  STV2A(I),I=LJ,JJ)                                  ********
 1055 FORMAT (10H       V 2A,2X,6F10.3)                                  WOUT 145
```

Listing of Code (continued)

```
      WRITE(6,1056)( STVU2A(I),I=LJ,JJ)                                          ********
 1056 FORMAT (10H      VU 2A,2X,6F10.3)                                           WOUT 147
      WRITE(6,1057)(STALF2(I),I=LJ,JJ)                                           WOUT 148
 1057 FORMAT (10H   ALPHA 2A,2X,6F10.3)                                           WOUT 149
      WRITE(6,1058)( STMF2A(I),I=LJ,JJ)                                          ********
 1058 FORMAT (10H      MF 2A,2X,6F10.5)                                           WOUT 151
      WRITE(6,1059)( STVZ2A(I),I=LJ,JJ)                                          ********
 1059 FORMAT (10H      VZ 2A,2X,6F10.3)                                           WOUT 153
      WRITE(6,1060)( STTS2A(I),I=LJ,JJ)                                          ********
 1060 FORMAT (10H      TS 2A,2X,6F10.1)                                           WOUT 155
      WRITE(6,1061)( STPS2A(I),I=LJ,JJ)                                          ********
 1061 FORMAT (10H      PS 2A,2X,6F10.3)                                           WOUT 157
      WRITE(6,1062)(STDEN2(I),I=LJ,JJ)                                           WOUT 158
 1062 FORMAT (10H    DENS 2A,2X,6F10.5)                                           WOUT 159
      WRITE(6,1063)(  STM2A(I),I=LJ,JJ)                                          ********
 1063 FORMAT (10H       M 2A,2X,6F10.5)                                           WOUT 161
      WRITE(6,5999)(CP2A(K),I=LJ,JJ)                                             ********
 5999 FORMAT(10H      CP 2A,2X,6F10.5)                                            ********
      WRITE(6,6000)(RV(5,K),I=LJ,JJ)                                             ********
 6000 FORMAT (10H      RG 2A,2X,6F10.3)                                           ********
      WRITE(6,6001)(GAM(5,K),I=LJ,JJ)                                            ********
 6001 FORMAT (10H    GAMG 2A,2X,6F10.5)                                           ********
      WRITE (6,6002)(RWG(5,K),I=LJ,JJ)                                           ********
 6002 FORMAT (10H     RWG 2A,2X,6F10.5)                                           ********
      IF(ISECT.LE.3)GO TO 21000                                                  ********
      WRITE(6,6003)(STWG2A(I),I=LJ,JJ),SFLO2A                                    ********
 6003 FORMAT (10H      WG 2A,2X,6F10.5,2X,11HTOTAL FLOW ,F10.5)                   ********
21000 IF(SRFLAG) WRITE(6,20000)                                                  ********
20000 FORMAT(1H1,45H AN EXIT HAS BEEN MADE FROM SUBROUTINE WOUT    )             ********
      RETURN                                                                     WOUT 162
      END                                                                        WOUT 163
```

Listing of Code (continued)

```
      SUBROUTINE PHIM(EXI,ETA,TR,PR)                                    PHIM 001
CPHIM                                                                   PHIM 002
      LOGICAL PREVER,SRFLAG                                             ********
      COMMON  SRFLAG                                                    ********
      IF(SRFLAG) WRITE(6,10000)                                         ********
10000 FORMAT(44H AN ENTRY HAS BEEN MADE IN SUBROUTINE PHIM   )          ********
      A = EXI-.5                                                        PHIM 003
      B = -(EXI+(1.-ETA)/2.)                                            PHIM 004
      C = ETA/2.                                                        PHIM 005
      X = (-B -SQRT(B**2 -4.*A*C))/(2.*A)                               PHIM 006
      TR = ETA/(ETA-X)                                                  PHIM 007
      PR = TR**EXI                                                      PHIM 008
      IF(SRFLAG) WRITE(6,20000)                                         ********
20000 FORMAT(45H AN EXIT HAS BEEN MADE FROM SUBROUTINE PHIM   )         ********
      RETURN                                                            PHIM 009
      END                                                               PHIM 010
```

APPENDIX III
CONTROL CARDS FOR WANL CDC-6600 COMPUTER

A. Control Cards for FORTRAN Deck Setup

	Example
JØB Card	JØB , 10.
Account Number Card	AS77987.
ID Card	ASD1097, TURBIN, 120, 75000, 01.
RUN Card	RUN (P,,,,,, 14000)
LØC Card*	LØC, 75000.
LGØ Card	LGØ .
End-of-Record Card	7/8/9
FORTRAN Deck	PRØGRAM JIM ....
' '	' '
' '	' '
' '	' '
' '	' '
' '	' '
' '	' '
' '	END
End-of-Record Card	7/8/9
End-of-Record Card	7/8/9
Data Deck	FALSE
'	'
'	'
'	'
'	'
'	'
'	'
'	'
	ENDJØB = 1.0 $
End-of-File Card	6/7/8/9

* The LØC card is required to initialize the core to zero before compilation and execution.

B. Control Cards for Binary Deck Setup

	Example
JØB Card	JØB, 10.
Account Number Card	AS77987.
ID Card	ASD1097, TURBIN, 120, 7500, 01.
LØC Card	LØC, 75000.
LØAD Card	LØAD (INPUT)
EXECUTE Card	EXECUTE.
End-of-Record Card	7/8/9
End-of-Record Card	7/8/9
Binary Deck	Binary Cards
'	'
'	'
'	'
'	'
'	'
End-of-Record Card	7/8/9
End-of-Record Card	7/8/9
Data Deck	Data Cards
'	'
'	'
'	'
'	'
'	'
'	
	ENDJØB = 1.0 $
End-of-File Card	6/7/8/9